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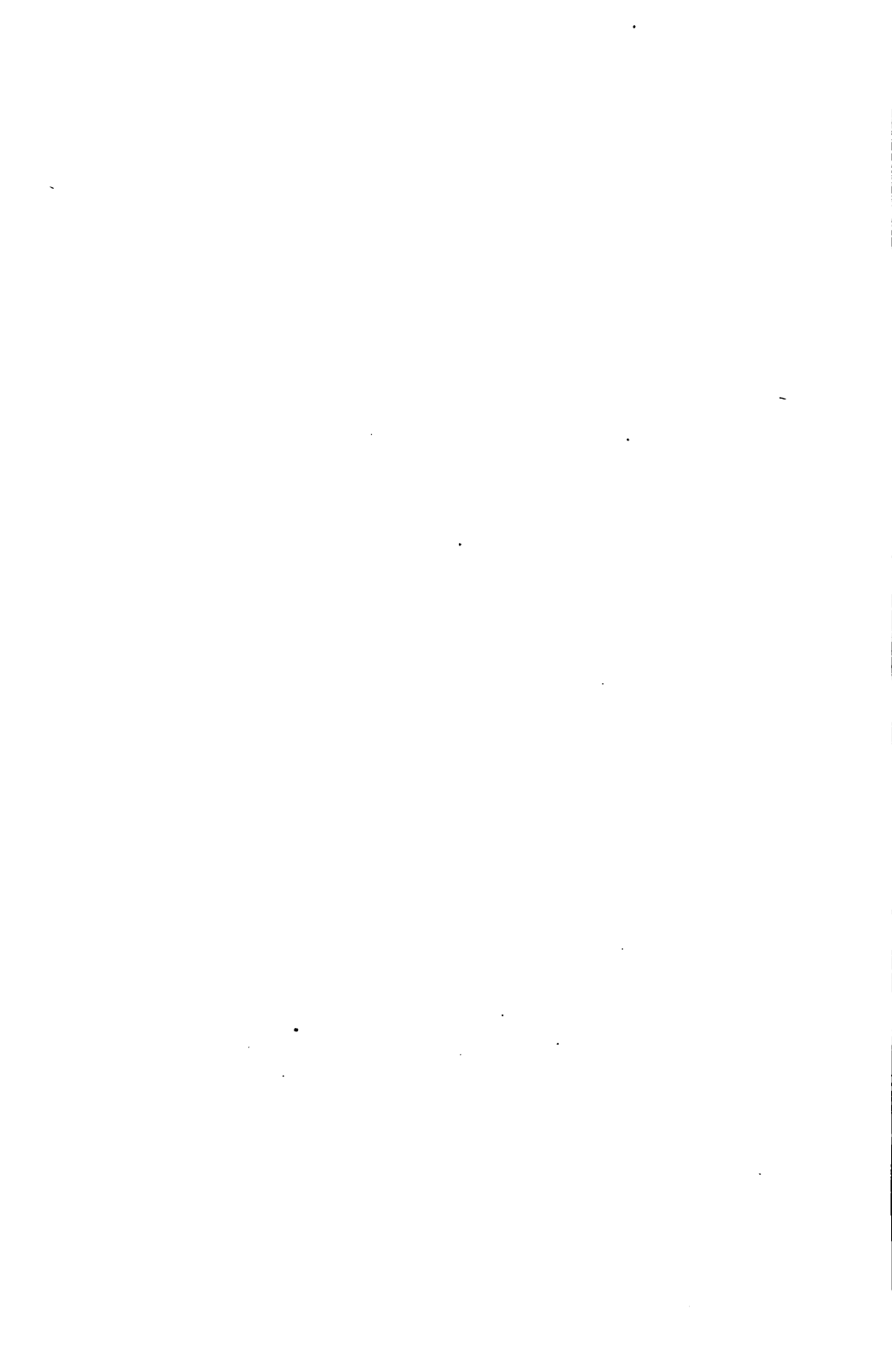


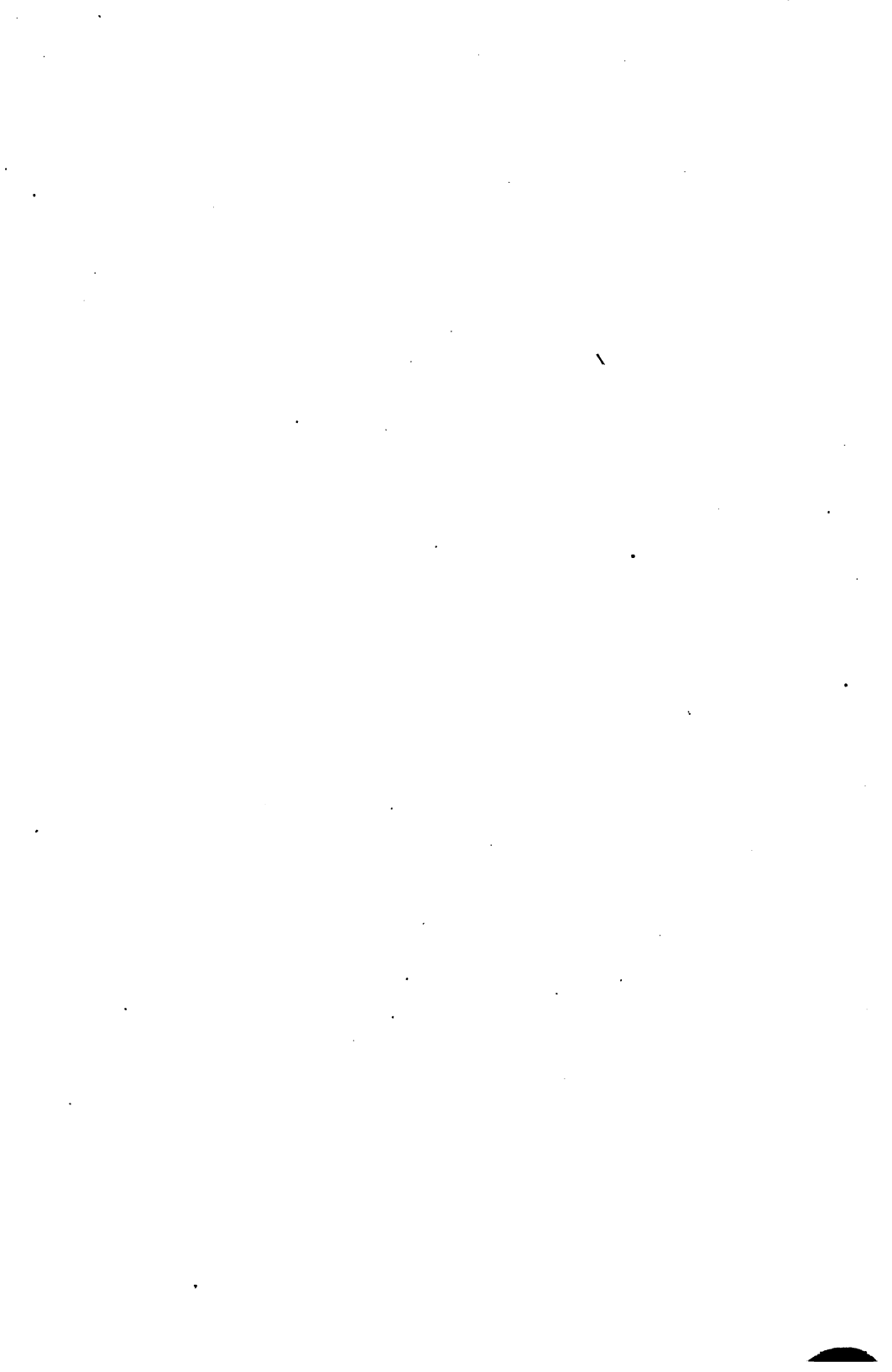
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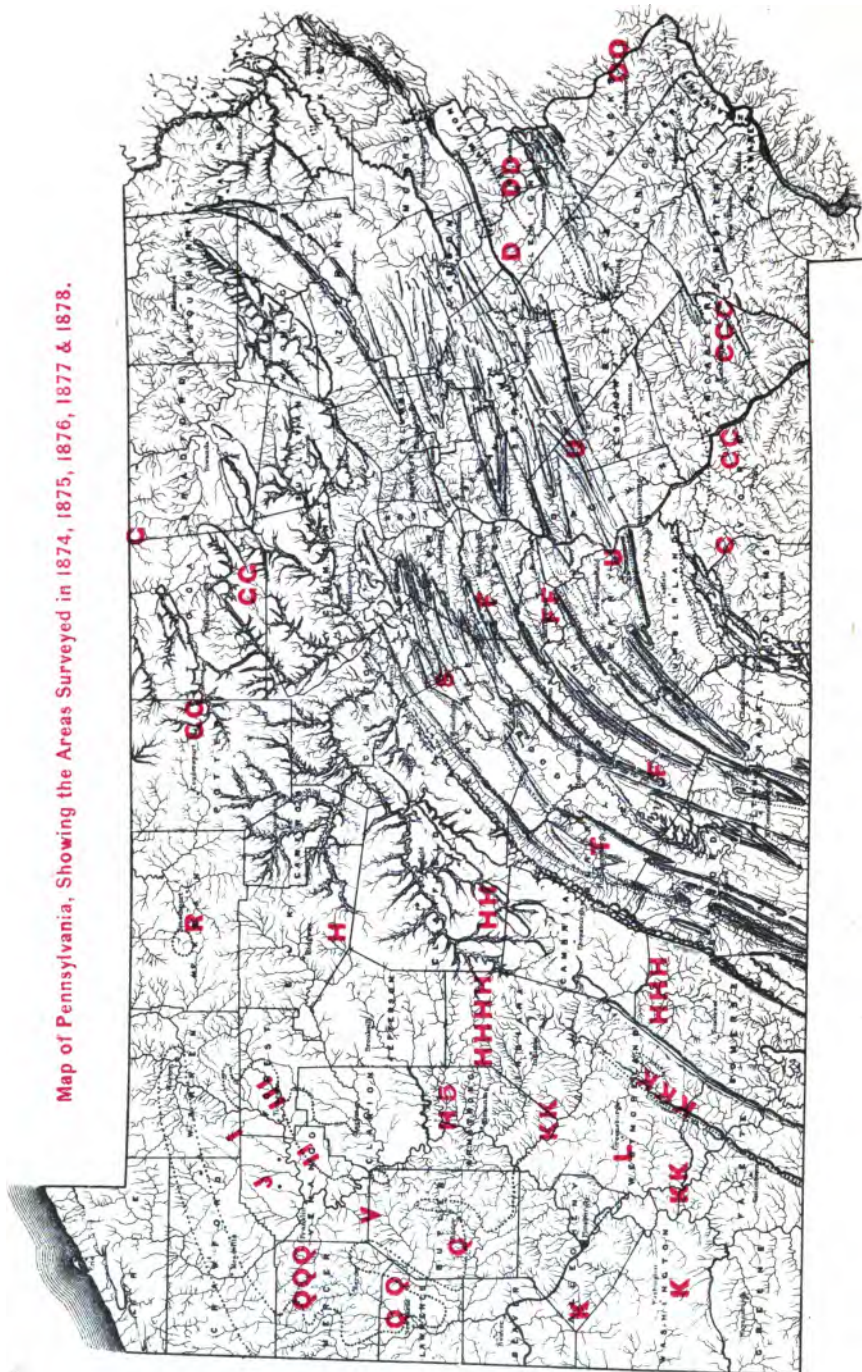
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Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877 & 1878.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS

V.

PART FIRST.

THE NORTHERN TOWNSHIPS

OF

BUTLER COUNTY.

PART SECOND.

A SPECIAL SURVEY MADE IN 1875

ALONG THE

BEAVER AND SHENANGO RIVERS

IN BEAVER, LAWRENCE AND MERCER COUNTIES.

✓ ✓
WITH 4 MAPS, 1 PROFILE SECTION AND 154 VERTICAL SECTIONS.

By H. MARTYN CHANCE.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.

1879.

c

Entered, for the Commonwealth of Pennsylvania, in the year 1879, according
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PREFATORY LETTER.

PHILADELPHIA, *April 23, 1879.*

PROF. J. P. LESLEY, *State Geologist:*

SIR: In submitting for your examination and approval the following report on northern Butler, I desire to invite your attention to the following points:

1. The well records and well elevations engrossed in Chapter X are reproduced from Report of Progress I.I. by Mr. John F. Carll, 1877, as necessary for the complete illustration of the stratigraphy of my district;

2. Certain sections along Slippery Rock Creek at no great distance inside and outside the western line of Butler County, obtained by me in 1875, are also included in this report for the same reason;

3. The instrumental survey of the Beaver and Shenango Valley which you directed me to make in 1875, and on which I reported to you in the winter of 1875-6, is included as Part II in this volume. The delay of its publication now permits me to explain the relations of its nomenclature with that of Prof. White's subsequent reports on Beaver and Lawrence Counties, Q, 1878, and QQ, in press, 1879;

4. My thanks are due to several gentlemen who have materially aided my surveys by furnishing copies of old surveys, levels, maps, and well records; and among these I would specially mention Messrs. Reis, Brown, and Berger, and Phillips Bros. of New Castle, Mr. Slataper of the Pennsylvania railroad, Pittsburgh, Mr. John Strawbridge,

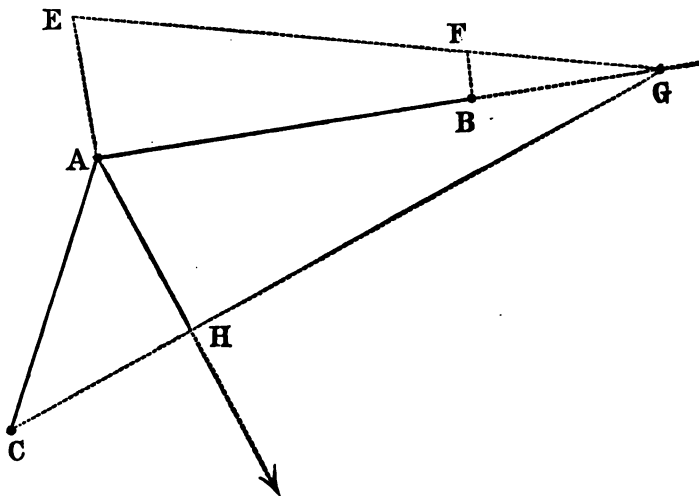
M. E. and Mr. John Nichols, C. E. of Sharon, Mr. Burnett of Greenville, and Mr. Robert Allen of Prospect;

5. In calculating the dip of the Sharon Coal bed in 1875, and subsequently in determining the dip of the oil sands for Mr. Carl's Report I.I.I., the question arose: "How can we determine whether a given rock conforms to a plane or to a warped surface?" To assist in answering this query I deduced the formulae given in a foot note to Chap. 1, Part II.

When four points on a stratum are located both geographically and hypsometrically, and the rates of dip between them reduced to a table, proceed as follows:

Take two of the given rates and calculate by the formulae the direction and strength of the true dip, then with two other rates go through the same process; if the second result agrees with the first, the stratum probably conforms to a true plane, but if they disagree, then the surface of the rock is a curved surface, or a plane broken by faults.

A very pretty graphic method for determining the direction and strength of greatest dip is given in the Geology of Ohio, Vol. III, page 940, 1879. It was devised by Prof. R. W. McFarland, of the Ohio State University. The annexed figure will explain the method more clearly than a written description:



The elevations of three points, A, B, and C, being given, let C be the lowest point. Join A and B by a straight line, and perpendicular to it draw two lines, AE and BF. On these lines lay off (on any scale) the respective heights of A and B above C. Join the tops of the perpendiculars E and F, and prolong this line until it intersects AB prolonged in a point G. Draw GC, and perpendicular to it draw AH, which is the required line of greatest dip. The length of this line divided into the dip between A and C will give the required rate per mile.

The scale used in laying off the heights AE and BF does not affect the position of the point G, for in the similar triangles AGE and BGF, the proportion $AG : BG :: AE : BF$, is always true, and the ratio $AG : BG$, (and consequently the length BG, for $AG = BG + AB$, which is a known quantity,) is dependent upon the *ratio of AE to BF*, and *not upon their lengths*.

In this construction C is taken as the zero point, and as the construction proves that G is also a zero point, the line CG is a line of no dip, *i. e.*, the "strike." A perpendicular to it is the line of greatest dip.

When four points are given the construction may be repeated by using a different combination, and if the resulting dip line is parallel to that determined by the first draught, the surface of the rock may be considered a plane.

If A = 900 feet above tide,

B = 800 " " "

C 750 " " "

B is 50 feet above C, and

A is 150 feet above C.

Then $BF = 50$ feet, and $AE = 150$ feet.

In the figure, $AC = 15$ miles,

$AB = 20$ "

$CB = 30$ " and

AH measures $10\frac{3}{10}$ miles $\therefore 150 \text{ ft.} + 10.3 = 14.6$ feet per mile, which is the greatest rate of descent or the true dip.

$$\text{The formula } \tan x = \frac{\cos y}{\sin y} - \frac{D''^*}{D' \sin y}$$

* See Part II, Chap. I.

applied to this example gives:

$$\tan x = \cotan 116^{\circ} 45' - \frac{5}{10 \sin 116^{\circ} 45'},$$

for angle CAB = $116^{\circ} 45'$ by measurement,

$$D'' = \text{rate of dip on AB} = (150' - 50') \div 20 = 5 \text{ ft. per mile}$$

$$D' = \text{rate of dip on AC} = (150' - 0') \div 15 = 10 \text{ " " "}$$

$$\tan x = -\cotan 63^{\circ} 15' - \frac{5}{10 \sin 63^{\circ} 15'} \therefore$$

$$\tan x = -.504041 - .5599 = -1.063941$$

$$x = 46\frac{1}{4}^{\circ} = \text{angle CAH}$$

When the tangent of x is *minus* the line of greatest dip falls *between* the two given courses, when *plus* it falls *outside* the line AC. The angle x is always less than 90° .

Applying $D = \frac{D'}{\cos x}$ to the above example we find D (or the true dip) = 14.6 feet per mile.

Yours, very respectfully,

H. MARTYN CHANCE.

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PREFACE.

The first part of the volume which is now published presents the results of certain special topographical and geological surveys made by Mr. Chance while acting as assistant to Mr. Carll in the Butler County Oil Region in 1876, and of the systematic detailed survey of the fifteen northern townships of the county, which he was afterwards commissioned independently to make in 1878.

In undertaking this survey he had the advantage of intercourse for consultation with Mr. Carll at the headquarters of the latter in Pleasantville, where many of his illustrations were drawn; and his expressed opinions are therefore in most respects those at which Mr. Carll had arrived in the course of his study of the Oil Regions in 1874, 5 and 6. But in some important particulars Mr. Chance arrived independently at views common to both. Mr. Carll's manuscripts on the limits of the Conglomerate system, on the ancient drainage of the country, on glacial drift, &c., written in 1875 have not yet been published, and will appear in his Report I.I.I. to which Mr. Chance more than once refers.

The second part of this volume consists of Mr. Chance's report of a survey of Slippery Rock, Shenango and Beaver river valleys which he was directed in 1875 to make for the special purpose of connecting the well known coal measures of the Ohio River Valley with the then almost unknown or very ill understood rocks of northern Butler and Mercer counties. This was a year before Mr. White was commissioned to pursue a systematic township survey of south Butler, north Allegheny and north Beaver counties, (Report Q, published in 1878).

In 1877 Mr. White surveyed Lawrence county (Report
(xiii)

QQ), and in 1878 Mercer county (Report QQQ), neither of which reports have yet gone through the press.

Mr. White's special survey of the Beaver and Mahoning, Ohio and Little Beaver valleys, for the purpose of rectifying a serious error which had been made in the adjustment of the Coal series in Ohio and in Pennsylvania—the report of which survey makes Part Second of QQ, and is called the Ohio Line survey—led him over part of Mr. Chance's previous work, now first published as Part Second of this volume.

We have therefore two entirely independent and accordant investigations of all the Coal Measures lying beneath the Ferriferous Limestone along the State Line; and no one will be likely to dispute seriously hereafter this part of the geology of Pennsylvania.

Whatever opinions respecting the identification of the Berea Grit, Mountain Sands and Oil Sands may be found expressed in this volume V, and in QQ and QQQ, must be considered of subordinate authority to the detailed discussion about to appear in Report I.I.I., where a far wider range is given to the arguments, and a more copious and precise illustration of the facts has been possible.

Both Mr. Chance and Mr. White have shown the greatest zeal and ability in sectioning the valley slopes and cliffs through Beaver, Lawrence, Butler and Mercer counties; but no zeal and no ability can overcome all the obstacles in the way of obtaining *complete* sections of the variable argillaceous and arenaceous beds beneath the Conglomerate. The fact is made evident on the face of the page illustrations by the numerous blank spaces and notes of interrogation seen in the section cuts. The further northward from the Ohio river such work advances the greater become these obstacles, so that in the Sharon district it is almost impossible to vouch for the accuracy of the whole of any section. Since there is seldom seen more than a few feet of rock exposed at any one place on the valley slope such a section must be compounded out of numerous unconnected exposures as they happen to be obtainable within a lateral distance of a half a mile, or a mile, or more. Therefore,

although the stratification is almost absolutely horizontal, yet, as barometric measurements are never precise, and the sand rocks are so numerous and so variable, there will always be questions of identity left unanswered.

It is in the region of oil wells that the order of our underground or lower rocks must be discovered; and four years of incessant labor has placed in Mr. Carll's hands so large a body of well records that no doubt can reasonably be entertained respecting the general correctness of his stratigraphical conclusions; as will be evident from a glance at his plates of grouped oil-well sections.

At the same time it is proper that every expert observer should not only be expected to arrive freely at his own opinions but be encouraged by their publication; provided always that the public be guarded against mistaking these individual opinions for the fixed and final decisions of science. Any *apparent* repetition of facts and statements in the reports of Mr. Carll, Mr. Chance, and Mr. White, into whose hands our Ohio Line geology has happily fallen, merely means independent observations and discussions of that geology; and since all three have observed *substantially* the same facts, where their districts overlapped, and have arrived at conclusions which are nearly identical, the people of Western Pennsylvania may feel confident that, so far as our systematic geology is concerned, there remains little more to discover; and that even as to the details, very little modification or alteration is to be expected in the future.*

The concluding chapters of this volume are to be read in the above sense.

Mr. Chance was directed in the autumn of 1878, previous to finishing his survey of Northern Butler county, to make a special study of the valley of the Susquehanna River West Branch in Clinton and Cameron counties, for the

* Too late to make a correction in the plate it was brought to my notice that paragraph second on page V. 141 states too positively what has not yet been demonstrated beyond doubt, viz. that the McKean county limestone is the Ferriferous Limestone of the Allegheny and Beaver river country. It is probably the same, but the proof is not yet complete.

purpose of discovering if possible the rate at which the Catskill, Pocono and Mauch Chunk formations IX, X, and IX thinned in the direction of Lake Erie and the Ohio State Line; and to determine if possible whether the Red rocks of the Oil Region were representatives of the red Catskill rocks; also, whether the red beds of the Mauch Chunk (Umbral) gave indications of feathering out to nothing before reaching the Oil Region. On the decision of these questions should also depend in some degree the view to be taken of the relation of the red Bedford shales of Ohio with the Reds of the oil region.

At the same time (1878) Mr. Ashburner was independently studying the same problem in his detailed instrumental survey of McKean and Elk counties.

Mr. Chance's results are only sketched out by him in the concluding chapters of this volume, and will be fully stated and perhaps corrected in his forthcoming Report VV on Clinton county.

Mr. Ashburner's views and reasons for them will be given in detail, with illustrative maps and sections, in his Report R on McKean and Elk, now nearly ready for the press.

The contour line map of northern Butler county, which accompanies this volume, is the first experiment made by the Survey in this direction. Mr. Chance, however, has had unusual advantages for constructing such a map, from the great number of oil-well-mouth elevations above tide taken during the course of the Survey of the Oil Regions. (See the tables of elevations given on pages 158 to 171 and in Report of Progress I.I.) Although similar contour line maps should be made of all the counties of Pennsylvania the funds appropriated annually by the Legislature for the prosecution of the geological survey are inadequate to meet the expense of the amount of leveling necessary for producing such maps in a reliable form. A trigonometrical survey of the State should also precede any such attempt.

From Mr. Chance's contour map a model of the northern half of Butler can be made, in relief, by any skillful engineer, or student of topography, and, if made on an equal vertical and horizontal scale, and cast in plaster, its surface

can be painted to represent the outcropping formations, and the block can be sawed in any direction so as to show painted sections of the underground. Such a saw cut, for example, if made so as to sever the block lengthwise of the oil belt, through some of the principal wells, will permit the oil sand group to be located with all its principal variations. A transverse slitting of the block would show the width of the oil belt and the feathering of the oil sands towards the east and west. It is my intention to add such a model to the models already constructed for the museum of the Survey when time permits.

J. P. LESLEY.

Philadelphia, June 13, 1879.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS, V.

1878.

By H. MARTYN CHANCE.

PART I.

NORTHERN BUTLER COUNTY.

CHAPTER I.

§ 1. *Topography, Drainage and Surface Geology.*

The district described in this report embraces that portion of Butler County lying north of the third tier of townships, or, in other words, the northern half of the county; and the facts now published are all essentially new additions to the geology of Western Pennsylvania.

The townships of Butler county are arranged geographically in regular squares and in the following order:—

	Mercer.	Marion.	Venango.	Allegheny.
	Slippery-rock.	Cherry.	Washington.	Parker.
Worth.	Brady.	Clay.	Concord.	Fairview.
Muddy Creek.	Franklin.	Centre.	Oakland.	Donegal.
Lancaster.	Connoquenessing.	Butler.	Summit.	Clearfield.
Jackson.	Forward.	Penn.	Jefferson.	Winfield.
Cranberry.	Adams.	Middlesex.	Clinton.	Buffalo.

The southern half of the county has already been very thoroughly described by Prof. I. C. White in Report "Q" on the Beaver River District, so that nothing remains to be said concerning it. In that volume the townships are reported upon in the following order:

- | | | |
|---------------|---------------|----------------------|
| 1. Cranberry, | 6. Winfield, | 11. Lancaster, |
| 2. Adams, | 7. Jefferson, | 12. Connoquenessing, |
| 3. Middlesex, | 8. Perry, | 13. Butler, |
| 4. Clinton, | 9. Forward, | 14. Summit, |
| 5. Buffalo, | 10. Jackson, | 15. Clearfield; |

beginning at the first or southern row, and following the description of these by the second row, which in turn is succeeded by the third tier.

In the present report the order from south to north is retained for the sake of uniformity; but each row of townships is described in an order from west to east.

The area covered by this report embraces somewhat over four hundred square miles, and may all be classed as hilly country. Most of the valleys are rather broad, with quite gentle side slopes, and but seldom are of the canyon like character shown by some of the gorges of Western Pennsylvania.

§ 2. *The Topographical Map.*

The annexed contour lined map has been prepared principally from an intricate series of barometric elevations of all the stream crossings and summits on every road in the district. These were obtained by careful duplicate readings at all cross roads, summits and hollows, and by frequent checks on spirit leveled lines, railroad stations, and oil well elevations. The work was done partly on horseback, and partly with a horse and buggy, so that in establishing the elevations of important points but little time was consumed in moving from one place to another. The elevations thus obtained were always carefully checked with previous work, and in all instances where the agreement was not good duplicate check lines were run. To better illustrate the method employed the following scheme is here given:

<i>Known points.</i>	<i>Points determined.</i>
Butler, R. R. elevation	to Sunbury.
Do.	to Prospect.
Prospect, (barometric)	to Sunbury [check].
Greece City, oil well elev.	to Sunbury [check].
Sunbury being now determined we have a good check on Prospect.	
Prospect, bar. check	to Centreville.
Sunbury, established	to Centreville [check].
Harrisville, R. R. elev.	to Centreville, established.
Centreville being established gives us another check on Sunbury.	
Sunbury, established	to North Washington.
Parker, R. R. elev.	to North Washington [check.]
Fairview—oil wells	to North Washington, es- tablished.

The elevation of North Washington brought by this method from Butler, checked within five (5) feet of the elevation as determined from Parker and Fairview. A careful use of this system in favorable weather cannot fail to give very good results, but during changeable weather bad checks will frequently be obtained and much of the work must be done twice over.

Besides the altitudes determined by the above method, I have used many obtained from the list of oil well elevations republished from Mr. Carll's Report I.I.I. in Chapter XI of this volume, and some determined by my surveyed line along Slippery Rock Creek, together with the levels of the Shenango and Allegheny, and Parker and Karns City Railroads.

The tide water elevation of the following towns is considered to be established :

1. Portersville, . . . 1360	8. Petrolia, . . . 1175
2. Prospect, . . . 1330	9. Centreville, . . . 1300
3. Unionville, . . . 1330	10. Annandale, . . . 1490
4. Millerstown, . . . 1210	11. North Washington, 1500
5. West Liberty, . . . 1190	12. Harrisville, . . . 1315

6. Sunbury, . . .	1400	13. Murrinsville, . .	1440
7. Middletown, . .	1420	14. Farmington, . .	1520

The ground plan of the map has been reduced from the township atlas maps, and is very nearly correct.

All the principal drainage features, and the relation of the geology to the topography, are clearly shown by the contour lines. The Ferriferous Limestone has been marked upon the map by a colored blue line. In carrying this outcrop line across the map, I fear that I may have shown it over some areas where the limestone is absent. It will be understood therefore that *where this stratum is not exposed*, the line is intended to show its horizon, or place at which it *should* outcrop.

§ 3. *The Parker Contoured Map.*

The area shown by this map was surveyed very minutely in August and September, 1876, with the intention of mapping the whole Butler Oil Belt, but it was found to be work of such difficult character, so slow, and consequently so expensive both of time and money, that it was thought best to carry it no further than over an area of about seven square miles back of Parker, and to publish it as illustrative of the belt of country bordering on the Valley of the Allegheny River.

On account of the many pipe lines crossing this area and running along the roads, accurate work cannot be done with a compass, and all of our work was necessarily done by transit.

The map shows the outcrop lines of the Clarion Coal Bed and Ferriferous Limestone.

Lawrenceburg is principally built on the flat eroded in the soft Mercer Measures, though the higher parts of the town are on top the Homewood Sandstone. The (upper) "Mountain sand,"—middle of No. XII,—which is probably the Upper and Lower Connoquenessing Sandstones united, forms the cliffs overhanging Parker City.

It seems quite probable that the high flat, which extends for a long distance back from the top of the cliffs, marks one

of the ancient flood planes, or the old stream bed, of the Allegheny River, prior to the time of its cutting down into the cliff sandstone. This view is confirmed by the topography of the opposite river bank, which exhibits a similar broad high flat, and indicates that at that time the Clarion River emptied into the Allegheny much farther south than its present mouth. These conclusions afford an easy explanation of the big bend in the Clarion, a short distance east of the Allegheny.

§ 4. *Dividing Ridges.*

The great dividing ridge between the waters of the Allegheny River on the east and the Beaver River tributaries on the west, sweeps through the eastern part of the county in a general direction nearly due north. It enters the county in Middlesex township, runs northeast through Clinton and Jefferson townships to Dilk's Station on the Butler Branch W. P. R. R., thence northward in an almost straight line to Middletown in Concord township. From Middletown it extends northward to North Washington and Annisville, and rounding in a semi-circle the headwaters of the Slippery Rock, passes close to Farmington; thence northwestward to the county line, along which it runs in a westerly direction, and sweeping again to the north runs off along the line between Mercer and Venango Counties.

Near Middletown it is joined by two prominent ridges coming in from the west. The first or most southern ridge is the divide between Muddy Creek and the Connoquenessing waters, which passes close to Portersville and Prospect, and runs nearly northeast through Centre and Concord townships to its junction with the great divide at Middletown.

The second ridge is the Muddy Creek and Slippery Rock Creek divide, which runs nearly due east from the Lawrence County line to Middletown, passing through Worth, Brady, and Clay townships.

Middletown may therefore be said to be the centre of the drainage system of Northern Butler. The head waters of

of the Slippery Rock, of Muddy Creek, Bear Creek, Buffalo Creek, and of Kearn's Branch of the Connoquenessing, are all found in its vicinity.

The heights of these dividing ridges above ocean level reaches 1,500 feet, or 600 feet above the Allegheny river at Parker. For example: at North Washington, 1,500'; at Farmington, 1,500' to 1,530'; at Middletown, 1,400'; at Sunbury, 1,400'; at Annandale, 1,490'.

§ 5. *Glacial Drift and Preglacial Drainage.*

South and east of the Muddy Creek and Connoquenessing Divide, the valleys are nearly all sharp and rather narrow cuts, with numerous small side ravines, and no well marked bottom lands, showing that an active aggressive erosion has been operative for a long period. The valleys lying north and west from this ridge are of quite different character, being generally much broader and more even in contour, with fewer side ravines. Drift banks are found at various elevations on the hill sides, and along the creek flats, and even on high land erratic blocks are of quite frequent occurrence. The latter are usually found in colonies, or strewed over the ground in narrow strips on either side of which but few can be seen.

At Annandale the Slippery Rock Valley contains flat bottom lands from two to five hundred feet wide. These become more and more noticeable as we go westward down the stream. A short distance below the mouth of Wolf Creek the valley is very broad and flat; and at the Red Bridge in Lawrence County this is a still more prominent feature. At the latter place water wells forty feet deep fail to find any bottom, passing through a succession of "muck," clay and gravel to a good clean gravel bed from which excellent water is obtained. Between Annandale and the mouth of Wolf Creek the stream often cuts down to bed rock, in some places running on top of the Homewood or Connoquenessing Sandstone for quite a distance. The creek is here probably flowing in a new channel, its old one lying farther south and being completely filled with drift.

From Rose Point in Lawrence County, southward to its junction with the Connoquenessing Creek it flows in a newly cut valley flanked on both sides by perpendicular walls of the Homewood and Connoquenessing Sandstones.

At some time prior to the Glacial period it probably had an outlet to the west through the valley of Big Run into the Beaver River below New Castle.

The valley of Muddy Creek presents similar bottom lands from Clay township westward to the Lawrence County line, and probably had an outlet through the same valley with Slippery Rock Creek. It must have flowed north from its present junction with the latter stream to its confluence with the ancient waters of the Slippery Rock, near Kennedy's Mills. Muddy Creek Falls is evidently a recent cut, produced by the rapid erosion of Slippery Rock Creek in its newly formed channel.

Erratic blocks on high land are found as far east as West Liberty, in Brady township, and Centreville, in Slippery Rock township, and along the creek bottoms much farther eastward. As Prof. Lesley, in his preface to Report Q, has discussed at considerable length their origin and the probable conditions of their distribution over the western counties, and as Mr. Carll in Report I.I.I, will give a very elaborate description of the Preglacial Water Basins, and the drift with which they are now filled; it is needless to add any thing more regarding them.

It would be well, however, to state that the data collected in the western part of the county, verify Prof. White's assertion that erratics are not found in the western counties at a much greater elevation than 1300' above ocean level.

§ 6. *Soil.*

There is but little first class farming land in the county, but much of the soil that is unfit for raising heavy crops is well adapted to grazing. Of late years this fact has been properly appreciated by the residents, and many are now turning their attention to sheep raising, which is found to pay very well.

Much of the land might be greatly improved by a liberal

use of lime, but either from ignorance of the fact, or from the expense attending its use, or from indifference, comparatively few use it at all, and those that do, apply it very sparingly.

The soil may be divided into four classes :

1st The soil of the Bottom Lands.

This is found only on Muddy Creek and its branches, and along Slippery Rock Creek and its main tributaries. It is very variable in character, sometimes being a loose sandy loam, forming excellent meadow land, and adapted to raising corn, hay, and all kinds of garden vegetables, but is occasionally a hard stiff clayey earth very difficult to cultivate and is also sometimes too swampy for farming purposes.

2d. The high lands of the Barren Measures in Muddy Creek, Franklin, Centre, Oakland and Donegal townships.

This soil is formed from the disintegration of clayey and sandy shale and sandstone, and varies from a rather thin loose soil, to a very hard tough clay. Much of it makes quite good farming land, and is well adapted to grazing, but sadly needs a liberal application of lime or some other inorganic fertilizer.

3d. The high land in southern Brady, Clay, Concord, and Fairview townships formed by the outcrops of the Mahoning and Freeport Sandstones. This land is very poor and but little of it is cultivated.

4th. The soil formed from the disintegration of the shales and sandstones of the Lower Productive Coal Measures. This covers fully four fifths of the district, and varies as much in quality as the coal measure rocks vary in their lithological character.

When the sandstones of the measures are rather friable with a calcareous cementing material, and the shales more sandy than argillaceous, very fair farming land is sure to result from their disintegration, but where there is an excess of clayey shales with no sandstone, or accompanied by very hard sandstones, a tough unyielding soil will always be found, utterly unfit for profitable farming.

A fifth variety might be made by considering the soil af-

fectured by the outcrop of the Ferriferous Limestone as a separate kind. Along the Slippery Rock Creek in Slippery Rock, Worth, Brady, Cherry, Mercer, and Marion townships, much of the land is very greatly improved by the presence of this rock, but it is so thin—rarely exceeding fifteen (15) feet—that we are hardly justified in asserting that there is any characteristic limestone soil in the county.

Apples and peaches are the only fruits commonly grown. The latter are small, hard and acrid, and are suited neither to the soil nor climate. The trees are usually planted around the margin of an apple orchard or a field bordering the road. This is done to insure to them the best drained soil. Some excellent apples are grown, but as the greater part of the county is not well supplied with railroads, but few are shipped to market.

CHAPTER II.

§ 7. *Anticlinals and Synclinals.*

All that portion of Western Pennsylvania lying north and west of the Brady's Bend or Fifth Anticlinal Axis was included in what is called the Sixth Bituminous Coal Basin.

This basin contains within its limits several minor flexures which divide it into as many sub-basins, but these anticlinals and synclinals have such gentle dips, and are so difficult to trace, that any attempt to classify them as separate sub-basins, and to trace them across the State as such, must prove futile, and be productive of much confusion with but little resulting benefit.

The Brady's Bend Anticlinal axis, crossing the Allegheny River in the loop below Brady's Bend, is said by Prof. White, to run in a straight line south 40° west across the southeastern corner of Butler County, just touching the northwest corner of Buffalo Township.

The Brady's Bend or "Sixth" Synclinal Axis lies but a short distance northwest from the anticlinal, crossing the

Allegheny River at Brady's Bend (East Brady) and entering Butler County at the southeastern corner of Donegal township, which is the most southeasterly point described in this report. Its course is approximately parallel to that of the Anticlinal axis.

§ 8. *The Millerstown Axis.*

A short distance southeast of Millerstown a gentle anticlinal roll is detected crossing the county in a direction approximately parallel to the Brady's Bend Axis. Its existence was first suspected about two years ago, 1876, when it was found that some of the oil wells drilled southeast of Millerstown reached the oil sand at a less depth than those nearer town.

A careful leveling of the well mouths, and a comparison of the relative depths at Millerstown, and on the Diviner Farm and others in the same vicinity, showed that the oil sand certainly dipped to the north over a strip of country a half mile or more in width. The data collected in obtaining the facts for the detailed township reports, show that the coal rocks also exhibit a north dip in that vicinity, and undoubtedly demonstrate the existence of an anticlinal and synclinal roll. No trace of it was observed northeast or southwest of Donegal township.

§ 9. *The Martinsburg Axis.*

A second flexure enters the county near Bear Creek, passes a short distance east of Martinsburg, where it can be detected by the eye, and probably passes, in its southwest course, very close to the town of Butler. It has governed the course of the main branch of Bear Creek, and of Kearn's Branch of the Connoquenessing and has probably had some agency in the production of the big bend of the Clarion River a short distance above its mouth. A description of the dips at Martinsburg will be found in Chapter VIII.

§ 10. *The Harrisville Axis.*

From the Martinsburg axis northwest to Centreville, no

perceptible flexure crosses the measures, the dip being nearly uniform and toward the south, but at the latter place a quite prominent anticlinal and synclinal roll is found. This anticlinal passing through the borough of Centreville is again seen in the coal mines at Harrisville Station. The north dips of this axis are frequently detected in the coals, and in the dip of the Ferriferous Limestone through all the country southwest of Centreville. It crosses the Beaver River about midway between the mouth of Connoquenessing Creek and Homewood Station.

The Harrisville Synclinal lies but a short distance, sometimes not over one half mile, from the anticlinal.

It determines the course of Wolf Creek and its junction with the Slippery Rock, and of the Slippery Rock and its junction with the Connoquenessing.

Traced northeastwardly, in the prolongation of this line, it passes a short distance west of Clintonville, crosses the Allegheny river at Scrubgrass, producing Scrubgrass Bend, and is again detected near Tippery Corners, six miles west by south from Oil City, where it brings the Ferriferous Limestone down into the hill tops.

The bend in the river at Scrubgrass has long been an unexplained feature in the erosion of the Allegheny Valley. The formation of Brady's Bend was elucidated years ago by Prof. Lesley, who has explained to us how the stream running down the dip to nearly the central line of the synclinal, was thrown back by the north dip, flowed for a time westwardly, but finally cutting across the basin was again deflected, this time toward the east, and began cutting back into the axis from the south; was once more repulsed, turned, and resumed its southerly course. A precisely similar action has taken place at Scrubgrass, resulting in the production of Scrubgrass Bend.

At Dotter's Siding, between Scrubgrass and Emlenton, there is a similar loop. This may have an origin similar to that of the other bends; but no flexure was detected in northern Butler that would account for it. If such an axis does exist it must be very gentle in the northern part of Butler county. It would correspond very nearly to a pro-

longation of Prof. Stevenson's Bulger Axis of Beaver County.

§ 11. *The Frederickstown axis.*

Prof. White, in Report Q, has supposed the anticlinal axis seen on the Beaver above Homewood Station (Harrisville axis,) to be the same with his Frederickstown axis. This construction would make the course of the flexure about N. 60° E., which is at variance with our knowledge of the structure of Beaver, Lawrence and Butler counties on the east, and in Ohio on the west.

The Bradys Bend axis runs N. 40° E. ; the Harrisville axis from Scrubgrass to the Beaver River about N. 42° E. and the Bulger axis in Beaver county about N. 30° E.

In Ohio, the flexures are more gentle, and consequently harder to trace, but have been proved to lie in a line more nearly parallel to the Cincinnati Anticlinal than the axes in Pennsylvania, *i. e.*, more nearly in a north and south direction.

It will then be seen, that if the Frederickstown axis be the same with the Harrisville axis, we have a flexure running across the general course of the axes and destroying the harmony of the system.

At New Castle, on the Beaver River, (see Part II below) there is a marked flattening of the dip ; so that the strata, as determined by spirit-level elevations of the Mercer limestone, appear to be horizontal for a distance of four miles. This can readily be explained by supposing that a rather flattened anticlinal roll crosses the river at that point.

If we now assume this flexure to be the same with the Frederickstown axis, we find its course is about N. 30° E. This is perfectly in harmony with the structure of the whole district, and is also in conformity with the course of the Ohio axes.

It is then safe to conclude that the Frederickstown axis is the same with the New Castle roll, and runs in a course of about N. 30° E.

The southerly prolongation of the Harrisville axis should therefor be looked for in the vicinity of Smith's Ferry, or at any point along a course S. 40° W. from Homewood Station.

CHAPTER III.

§ 12. *The Barren Measures.*

Only the lower portion of the Barren Measures is found in this district. In parts of Muddy Creek, Franklin, Centre, Oakland, and Donegal townships, over one hundred feet of strata belonging to this series is caught in the hill-tops, but no good section of them could be obtained within the limits of the district.

The following section is taken from Report Q, page 24, and is given as a typical section of the Barren Measures in Southern Butler and Allegheny counties. In it, the Mahoning S. S. is made the lowest member of the Series, but heretofore that rock has always been regarded as the top rock of the Lower Productive Coal Measures.

The Mahoning Sandstone will be described in connection with the Lower Productive Coal Measures.

The highest rocks of the Barren Measures are found in the high lands of Centre township, where the lowermost two hundred feet of these strata is caught in the hill-tops. This is a very exceptional thickness, as usually there is not much more than one hundred feet of these measures found so far north as this tier of townships.

Neither the Bakerstown Coal bed, nor the Pine Creek Limestone were detected ; but they might easily be present and yet escape observation, as they must lie only in the highest hill-tops, and have probably suffered greatly from aerial erosion.

The Buffalo, or Mahoning Upper Sandstone is not a massive rock in these townships. It is usually replaced by soft clayey shales, and argillaceous sandstones.

The Brush Creek coal is nowhere of any importance. Its outcrop is seen along the road-summits in many portions of the southern part of the district, but is always too thin and impure to be of any value. The Brush Creek Limestone is probably absent.

General Section of the Barren Measures in Allegheny County.

Pittsburgh Coal Bed,	
Concealed,	20'
Pittsburgh Upper Limestone,	2'
Variegated Shales,	65'
Pittsburgh Little Coal, wanting.	
Pittsburgh Lower Limestone,	5'
Red Upper shale,	20'
Concealed,	70'
Morgantown SS,	45'
Small coal,	—
Variegated shale,	50'
Elk Lick Coal,	0' to 3'
Elk Lick Limestone,	0' to 5'
Variegated Shales,	35'
Berlin Coal, wanting.	
Green Crinoidal Limestone,	2' to 3'
Platt (?) Coal,	0' to 1½'
Red Lower Clay Shale,	30'
Sandy Shales and Shaly SS.,	50'
Bakerstown Coal,	0' to 4'
Shales and Sandstones,	40'
Pine Creek Limestone,	2'
Buffalo (Mahoning Upper) SS.,	60'
Brush Creek Limestone,	1' to 2'
Dark Shale,	10' to 15'
Brush Creek Coal,	0' to 3'
Shale,	20'
Mahoning Sandstone,	40' to 80'



The Mahoning Sandstone, underlying the above described

series, is often almost entirely replaced by soft Barren Measure shale; but is sometimes quite a massive stratum, forming prominent topographical features. It caps the dividing ridge north of Muddy Creek in Brady and Clay townships, and is occasionally a massive stratum in Oakland and Donegal townships.

CHAPTER IV.

§ 13. *The Lower Productive Coal Measures.*

No complete section of the Lower Productive Coal measures can be obtained within the limits of the county. Even when the exposures are good, and are close enough to each other to be joined together with no risk of erroneous identifications, the resulting sections are always more or less incomplete, for all the coal beds, and their accompanying limestones, are never present together in any one locality.

The following generalized section has been prepared from a thorough revision and verification of Prof. Lesley's Section at Brady's Bend. It embraces all the coals of the series, except the Millerstown and Ferriferous Coal Beds.

The maximum and minimum thickness of each stratum is given in the left hand column of figures; and the measurements at Brady's Bend in the right hand column. The section is thus made a typical one for the district, and can be used as a key to any section measured in northern Butler, northern Armstrong, Beaver or Lawrence counties.

It will be noticed that though the intervals are represented as being subject to great variations in thickness, the general parallelism of the measures is preserved, as as a thickening or thinning in one stratum is always compensated by a corresponding increase or diminution of the interval above or below it. Thus, the Freeport Sandstone ranges from 36 to 60 feet in thickness, but this variation is always compensated by an opposite variation in the overlying or underlying strata; so that the distance from the Freeport Limestone down to the Kittanning Upper Coal

bed, or to the Ferriferous Limestone, remains nearly constant.

The section here given does not include all of the Brady's Bend Section. It is only carried down to the bottom of the Brookville Coal Bed, which at Brady's Bend lies about 165 feet above low water in the Allegheny River. The strata beneath this bed belong to the Beaver River or Conglomerate Series (No. XII).

Generalized Section of the Lower Productive Coal Measures.

30' to 70' Mahoning SS., sometimes containing Millerstown Coal, . . .	50'	<div style="text-align: center;">V. 2</div>
0' to 70' Slate and shale, sometimes replacing Mahoning SS.,	25'	
1' to 6' Freeport Upper Coal, . . .	5'	
5' to 20' Fireclay and shale ore balls,	8'	
0' to 5' Freeport Upper Limestone,	5'	
5' to 15' Fireclay with ore—Shale, . . .	13'	
0' to 4' Freeport (Summit) Ore, . . .	3'	
25' to 35' Freeport Upper Sandstone, sometimes shale, . . .	30'	
1' to 8' Freeport Lower Coal, 1½' to 4'		
0' to 5' Shale or Fireclay, . . .	3'	
0' to 2' Freeport Lower Lime, 2'	65'	
40' to 60' Freeport Lower SS., 60'		
0' to 10' Shale or Slate,	—	
0' to 4' Kittanning Upper Coal, 10" to 3'		
1' to 3' Fireclay,	—	
30' to 45' Sandstone and shale, . . .	46'	
1' to 4' Kittanning Middle Coal, 2' to 4'		
3' to 8' Fireclay,	5'	
35' to 40' Shale, olive and blue, 35'	40'	
1' to 4' Kittanning Lower Coal, . . .	3'	
1' to 5' Fireclay,	3'	
1' to 20' Sandstone, sandy shale, 23'	28'	
0' to 3' "Slab" ore,	—	
12' to 18' Sandstone and sandy shales, ferruginous, . . .	14'	

0' to 5'	Limestone (Buhrstone) ore,	1'
0' to 22'	Ferriferous Limestone, . .	15'
	Scrubgrass Coal, ?	
18' to 30'	Sandy shales,	25' }
2' to 7'	Clarion Coal Bed, . . .	3' }
1' to 3'	Fireclay,	2' }
20' to 40'	Soft shale or sandstone, .	25'
0' to 6'	Brookville Coal Bed, (?) .	3'
0' to 10'	Fireclay or shale, about .	5'
	Homewood Sandstone.	

Total, : 423'

The figures bound by a vincula are those used in constructing the accompanying section, Fig. 2.

Several instrumental measurements at Brady's Bend gave a mean of 264 feet as the distance from the Freeport Upper Coal down to the Ferriferous Limestone. This tallies well with the results obtained by Mr. White, who gives, (see Q, page 39,) the distance from the Upper Freeport Coal to the Ferriferous Limestone, as—

At Kittanning,	261'
At New Brighton,	263'
At Smith's Ferry,	242'

Throughout the district I have always found this interval greater than 250 and less than 265 feet.

The thickness of the Lower Productive Series (counting in the Mahoning Sandstone) in northern Butler and Armstrong counties and the eastern part of Lawrence county, is always from 400 to 425 feet.

§ 14. *Ancient Erosion of the Freeport Group.*

This thickness is sometimes diminished by an apparent replacement of the Mahoning Sandstone, and Upper Freeport Coal and Limestone, by the shales of the Barren Measures. In many localities in the southern part of the district, the Freeport Group cannot be recognized. No coal or limestone is found at the proper horizon, and the overlying Mahon-

ing Sandstone is entirely cut away by shales, lithologically the counterpart of the Barren Measure Shales. It may be urged that the Freeport group was never deposited over this area, and that this is a bona fide disappearance of the group; but against this view there are many objections. Northeast, north, and west of the areas in which the above described phenomenon is observed, both the Freeport Group and Mahoning Sandstone are found with almost their normal development and at a nearly constant distance above the Ferriferous Limestone and Kittanning Coal Beds. It is therefore improbable that we have here reached the northern margin of the old Freeport Basin, as all the facts seem to indicate that their absence is occasioned by an ancient erosion.*

§ 15. *Extent of the Freeport Coal and Limestone.*

The rapid deterioration of this group, north, west, and

*Erosion of a group of Coal Measures previous to the deposit of the next group in the order above it, must be a fact of the highest importance to the Theory of Coal, and should be settled beyond doubt. I have invited attention to the evidence obtained by Professor Stevenson (in Greene and Washington counties, as published in his Report of Progress K, 1876,) in the Preface to Professor White's Report of Progress, Q, pp. xlii to xlv. In that case the erosion took place not long before the deposit of the Pittsburgh Coal. In this case, if Mr. Chance is correct in his inferences, a still older erosion had taken place, even before the deposit of the Black Fossil Limestone of the Barren Measures. It is not to be supposed that erosions of such a depth as to cut out a whole group, or such as to make a valley one or two hundred feet deep, were effected under water, by any conceivable ocean currents. They must be looked upon as subaerial. The Coal area must therefore have been at intervals high out of water, and then submerged. If we possess two well authenticated cases, there may be any number of others not yet discovered.

If large stretches of land appeared above water at one time, there could have been at first no vegetation upon them; and if the climate was hot and even approximately dry, there must have occurred extensive and deep *aërial deposits of blown sand and clay dust*. These may explain some of our coal measure sandstones. My study of the loose yellow sand formation, ("Conglomerate, No. XII,") of Paint Fork of Sandy river, in East Kentucky, in 1864, (see Proc. Amer. Philosoph. Soc., April, 1865, Vol. X, p. 47 et seq.), impressed me strongly with the idea that it was a great irregular sandstone deposit; and only the presence in it of fragments of trees prevented me from so describing it. It rapidly and locally varies from 150 to 250 feet in thickness, and is almost entirely destitute of the usual marks of water bedding.

J. P. L.

northwest from Brady's Bend indicates however that we cannot be far from the northwestern limits of these coal beds, and suggests the query: Over how wide an area were they originally deposited? North and northwest from Brady's Bend in Butler county, the Upper Freeport Coal is but seldom a workable bed, and is often apparently absent. In the southwestern part of the county it is never valuable, and in Beaver county it is always a thin bed and can but rarely be seen. Over this area then we may consider it of poor development, such as we would expect to find in the marginal area surrounding its central basin of deposition. In the Pittsburgh Well record no member of the group is reported, the place where the coals, limestone and fireclay should be found being filled by sandstone.

East and southeast from Brady's Bend the Freeport Group has its best development, and may be traced as a valuable coal and ore bearing series southward to the State line, and eastward to the face of the Allegheny Mountains. We can therefore assign no limits to its southern and eastern extension.

§ 16. *The Millerstown Coal and Mahoning Sandstone.*

This Coal Bed has been named from the borough of Millerstown in Donegal township, near which it is of greater thickness and better quality than at any other locality in the county. It occurs in the horizon of the Mahoning Sandstone, at from two hundred and ninety-five to three hundred and fifteen feet above the Ferriferous Limestone, and from thirty-five to fifty feet above the upper Freeport Coal Bed.

It varies from two to five feet in thickness but is never of very good quality, and is usually quite a poor coal, but has been mined quite extensively for use at the oil wells between Karn's City and Millerstown, and has also been mined to some extent by the Karns City and Butler R. R. Co., who have a bank opened upon it near the former place.

In the absence of good exposures, or of oil well records

giving the depth at which the Ferriferous Limestone was struck, this coal might often be mistaken for the Freeport Upper bed.

A coal occupying the same geological horizon as this bed is noted in Report Q, p. 106, as occurring in Forward township. Prof. Lesley's description of the Brady's Bend rocks also notes a coal five feet thick at this horizon in the Mahoning Sandstone, (and sixty feet above the Freeport Upper Coal,) which is undoubtedly the same with the Millerstown bed.

The Mahoning Sandstone, in the presence of this coal is usually replaced by shale or shaly sandstones, and is sometimes split into two bands of rather soft shaly sandstone. It is seen as a quite massive rock, capping the hill tops of Brady township, but is usually of rather shaly composition and fails to make any prominent topographical features.

§ 17. *Freeport Upper Coal.*

This coal is locally a workable bed in several localities in Oakland, Donegal, Clay, and Concord townships; but over the remaining townships of the district it is an almost worthless bed. It has nowhere a thickness or quality that will compare with its exhibit at Brady's Bend, and is often altogether absent.

§ 18. *Freeport Upper Limestone.*

This stratum is seen less frequently than the Upper Freeport Coal. In some parts of Muddy Creek, Franklin, and Clay townships it is an apparently persistent bed, but over a large part of the district no trace of it can be found.

Attempts have frequently been made to burn it for agricultural purposes, but it yields a lime of such dark color and impure character that nearly all farmers are prejudiced against its use. It is never accompanied by any good ore.

This limestone is characteristically different from the Fer-

riferous Limestone, and lies about two hundred and forty to two hundred and sixty feet above it.

When the latter rock is very thin, it occasionally has nearly the same appearance as the Freeport bed; but wherever the stone is exposed to direct erosion the difference is immediately detected. The Freeport Limestone weathers into extremely hard yellow clay-incrusted nodules, while the Ferriferous nearly always breaks into slab like pieces with irregularly undulating surfaces, and of a bluish or dirty white color. Its outcrop along the road sides is always marked by a light slate-colored clayey soil, and by fragments lying in the road, which, after being bruised by passing wagons, are very noticeable.

§ 19. *Freeport Lower Coal.*

This coal is a very irregular and unreliable bed, and is workable over but a small area. Its greatest thickness is found in Clay, Concord, Washington and Parker townships, over a large part of which it can always be found; and is generally of workable size. In some localities—as at North Washington, and in Parker township—it has locally an enormous thickness, measuring sometimes as much as fourteen feet; but where this abnormal size obtained the whole bed is not good coal, and only its lower half is mined.* In Clay township it is usually about five feet thick, and always in two nearly equal benches parted by about one foot of slate.

Over the remainder of the district it is generally of poor quality, but seldom more than one or two feet thick and is opened in very few places.

§ 20. *Freeport Lower Limestone.*

This stratum is usually quite thin, rarely exceeding one

* In one mine a measurement of sixteen feet was reported.

foot in thickness, and is exposed in very few places in the district.

In Parker township an ore bed is found in local patches occupying the horizon of this limestone. It is said to be of excellent quality, and was much esteemed by the owners of the old furnaces on Bear creek, who mined it quite largely as long as the stacks were in blast.

In the oil well records kept by Mr. John H. Carll, (reprinted in Chapter X,) this limestone is noted at a distance of from one hundred and eighty to two hundred feet above the Ferriferous Limestone. The stratum is evidently very thin, and was not noticed by the men who drilled the wells, but I afterwards detected it in the sand pumpings that Mr. Carll had carefully preserved for future reference. It may belong somewhat above the place assigned to it in the printed sections.

§ 21. *Freeport Lower Sandstone.*

This is the Freeport Sandstone of the First Survey, and can be recognized throughout the whole district. Its thickness can be said to vary from forty to sixty feet, though it is sometimes slightly in excess of the latter figure. In some of the old sections a much greater thickness is given to this rock, but in every instance this has been obtained by including in the measurement the Upper Freeport Sandstone, or the sandy shales that are sometimes found beneath the place of the Kittanning Upper Coal.

It is usually a rather shaly, finegrained rock, and always shows more or less false bedding.

A peculiar local coal bed occurs near the middle of the mass of shales, which in some localities replaces the sandstone.

This coal has been called in this report "The Currie Local Coal Bed," and in Prof. White's Report Q, p. 121, the "Eichenhaur Local Coal." It consists of two benches, partly cannel and partly bituminous coal, separated by a

band of shale or sandy fireclay from a few inches to two feet in thickness.

It is difficult to conceive how a local bed of this character could have been formed during a period in which a great sandrock like the Freeport Sandstone was being deposited, and we are again forced to use the well worn hypothesis of "drifted carbonaceous material" to explain its origin.

§ 22. *Kittanning Upper Coal.*

This bed underlies the Freeport Sandstone by from five to fifteen feet, and overlies the Ferriferous Limestone from one hundred and ten to one hundred and thirty feet. In its thickness and quality it very closely resembles the Kittanning Middle coal, and is somewhat similar to the Kittanning Lower bed. In fact all three of the Kittanning coals are very similar to each other. This bed is the same with Mr. White's "Darlington" Bed, and lies from thirty to forty-five feet above the Kittanning Middle Bed.

It is a good workable bed, from two to four feet thick, in parts of Worth, Brady, Slippery Rock, Parker, Washington and Venango townships. In the two last named townships it is a cannel coal of very good quality, but over the remainder of the district always a bituminous coal.

§ 23. *Kittanning Middle Coal.*

This coal is absent in the Kittanning section, and has never heretofore been assigned its right position in the series. It underlies the Kittanning Upper coal from thirty to forty-five feet and overlies the Ferriferous Limestone from seventy to ninety feet.

It is a very persistent bed, is nearly always of good quality, and is of workable size in parts of Muddy Creek, Franklin, Worth, Brady, Clay, Slippery Rock, Cherry, Washington, Parker, Mercer, and Venango townships.

§ 24. *Kittanning Lower Coal.*

This coal lies about forty feet above the Ferriferous Limestone, and forty feet more or less below the Kittanning Middle bed. Its best development in Butler county is found in Parker and Allegheny townships.

Over the remainder of the district it is seldom of workable size. In Venango county just north of the county line it is a fair bed, and at Brady's Bend is quite valuable, being the "Furnace" Bed that was so largely worked by the Brady's Bend Iron Company. At Brady's Bend it lies forty feet above the Ferriferous Limestone, and at Kittanning fifty feet above the same stratum.

§ 25. *The Kittanning Group.*

Though I have found in some places all three of the Kittanning coals present, there is no locality in Butler county where they are all of workable thickness. In many parts of Butler, Allegheny, Beaver, and Lawrence counties two good coal beds are found between the Ferriferous limestone and the Freeport sandstone. The conclusion that there were but two persistent beds in this horizon was consequently a reasonable one; so the Middle Kittanning, in the presence of the Upper Kittanning Bed, was called the Lower Kittanning Coal; and in the presence of the Lower Kittanning, was mistaken for the Upper Kittanning. The former error was made over that area in which the Middle Kittanning is absent, and the latter in a part of State where the Lower Kittanning is but rarely seen. Where three coals were found the extra bed was supposed to be merely a local deposit, which should not be placed in the series as one of its persistent members.

In the central part of Butler county, all the complete sections show three beds of coal within the limits of this group. In the north-eastern part of Franklin township the Upper and Middle Kittanning coals are both opened and worked, lying about forty-five feet apart, and the Lower Kittanning coal was reached in a well starting on a level

with the Middle Kittanning bed, at a depth of forty feet. The two upper beds are also of good size at Stone House in Brady township, but only the upper bed is there mined. They are both opened and worked near Harrisville and Centerville, where the smut of the Lower Kittanning Bed is frequently seen on the roads. The lower bed is thin and almost worthless, and lies about forty feet above the Ferri-ferous Limestone.

In Parker township the Lower and Middle beds have been opened, but they are both rather thin. The upper bed is here a cannel coal and little mined, but the lower bed has been worked quite largely for use at the wells.

These three coal beds, when of workable size, exhibit a striking similarity to each other. They are all characteristic gas coals, averaging about thirty-eight per cent. of volatile matter, and yield about fifty-eight per cent. of coke. The following rude generalization will show their general character:

Water,	1.50 to 2.50
Volatile Matter,	36.00 to 41.00
Fixed Carbon,	46.00 to 54.00
Sulphur, . . . . .	.70 to 1.90
Ash,	4.00 to 10.00
Coke,	56 to 60 per cent.

A good specimen taken from any one of these coals will on analysis, be found to agree very nearly with the mean of the above figures.

Mr. White gives several analyses of the Lower Kittanning Coal at New Brighton (Middle Kittanning of this report, the Lower Kittanning being apparently absent in that locality) which show about the same character. In eight separate analyses the maximum and minimum figures are:

Water,	1.620 and 2.400
Volatile Matter,	36.470 and 41.260
Fixed Carbon,	43.263 and 54.619
Sulphur, . . . . .	.791 and 4.177
Ash,	4.080 and 12.570

The following general scheme shows the arrangement of

the group as correctly as a detailed description, and will be useful as a key to any section compiled in the district, It can be very easily remembered :

Freeport Lower Sandstone,	_____	
Kittanning Upper Coal,	—	3'
Interval,	40 ft.	—
Kittanning Middle Coal,	—	3'
Interval,	40 ft.	—
Kittanning Lower Coal,	—	3'
Interval,	40 ft.	—
Ferriferous Limestone,	_____	

The Ferriferous Coal Bed occurs in the interval between the Kittanning Lower Coal and the Ferriferous Limestone, but is of no value within the county limits. Its blossom is frequently seen in the northern townships, but is always quite thin ; it is also seen in several places on Slippery Rock, creek, but is never thick enough to be valuable.

§ 26. *Ferriferous Limestone.*

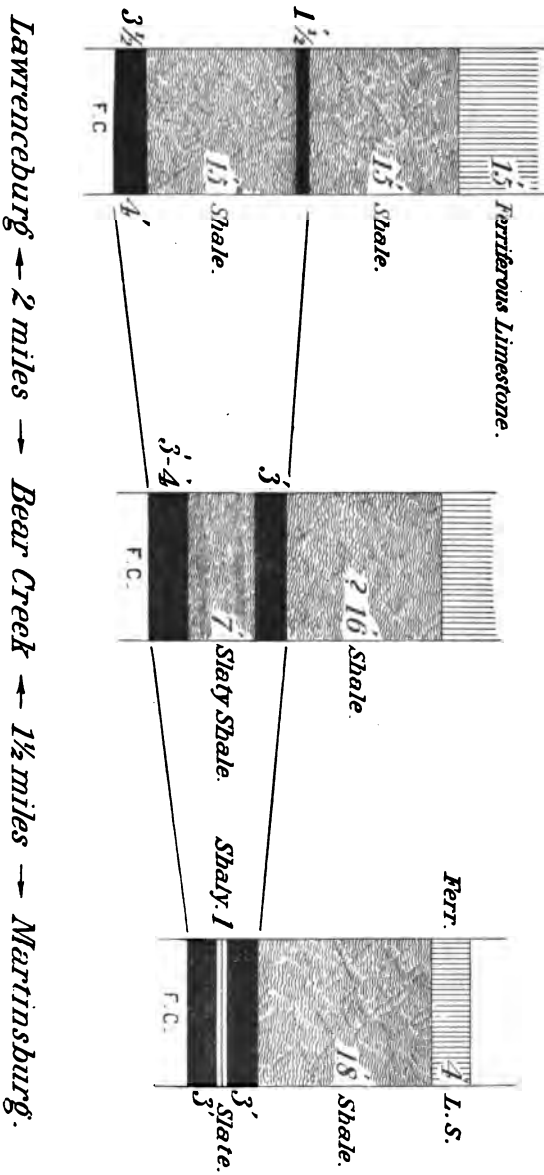
This is the most persistent and valuable limestone found beneath the Pittsburgh Coal seam. It is of its usual thickness and character over nearly all of Butler county, but is not quarried to any extent. Its exposures therefore are not so frequent as in the country east and west of this district, where it is finely exposed in a large number of quarries. The ore bed usually found immediately on top, or in the shales above it, is mostly thin, and has been dug in very few places.

A full description of this limestone and its ore bed is given in Chap. X, of this Report.

The Scrubgrass Coal Bed immediately underlies the limestone and has been detected in the northwestern part of the county, where it is commonly known to be present, but is too thin to be mined. Its usual thickness is from six

Diagram showing the Clarion Coal split into two Beds.

Fig. 3



inches to one foot but in one locality it is said to be 18 inches thick. A short distance west from the county line in Lawrence county a bank is opened upon it, from which some good coal has been taken. It is there about two feet thick.

This bed is probably a split from the Clarion Coal, and on that ground it has been denied a place in the preceding generalized section.

§ 27. *Clarion Coal.*

In the vicinity of Parker and Martinsburg this bed is mined quite largely. At the former town it is about four feet thick, but is a very sulphury coal and not much used except at the oil wells.

At Martinsburg the bed measures seven (7) feet, consisting of two benches of about three feet each, parted by a band of slate one foot thick. Going southward this slate in places almost entirely disappears, but in a northeasterly direction, towards Donnelly Station, rapidly swells to seven (7) feet, making the measurement of the whole bed about thirteen feet. The upper bench is almost entirely lost before reaching Parker. Prof. Rogers gives a thin coal as occurring between the Clarion and Ferriferous Limestone at Lawrenceburg, which is probably this upper bench in an attenuated condition.

The diagram given in Fig. 3, shows with clearness this remarkable splitting, and the confusion into which it might lead us, for at Lawrenceburg there are apparently *two seams* which (by supposing a slight change in the intervals) could easily be mistaken for the Clarion and Brookville, or for the Scrubgrass and Clarion coal beds.

The absence of the Scrubgrass coal south and southeast from Martinsburg, and its almost universal presence north and northwest from this locality, make it probable that it is in reality but the upper bench of the Clarion Bed, and not as hitherto supposed, an individual seam. This conclusion would destroy any supposed triple character of the

Clarion group, and compel us to recognize in it *two* beds only: the Brookville and the Clarion.

On Slippery Rock and Wolf Creek the Clarion Coal is rather thin, and little worked. At Pardoe, in Mercer county, it is four feet thick and is largely mined by the Mercer Mining and Manufacturing Company.

It is opened at a few banks in the northern tier of townships, but is usually either too thin or too slaty and sulphury to be a valuable bed. In Venango county just north of the Butler county line it has been opened and worked at several banks for many years.

§ 28. *The Brookville Coal Bed.*

The Brookville Coal is opened and mined at a few places in the northern tier of townships. It varies from a few inches to five feet in thickness, but is never a valuable bed. Even when it is four or five feet thick, the many sulphur bands which the coal contains render it nearly worthless.

§ 29. *Ancient Anticlinal Axes.*

In many localities—as at Martinsburg and on the Slippery Rock creek—the top of the Homewood Sandstone rises above the horizon of the Brookville and reaches nearly up to the Clarion bed. In these instances the sandrock does not show any apparent thickening, but simply appears to lie nearer to the Ferriferous Limestone than it does when in its normal horizon. The change is therefore to be attributed to the measures above this rock, and not to the sandstone itself, and may possibly have been occasioned by the existence of ancient anticlinal waves prior to the deposition of the Brookville coal bed.

§ 30. *Key Section to the Butler County Coals.*

The following generalization will be useful as a Key Section to the Lower Productive Coal Measures of the district.

The Ferriferous Limestone is used in it as the Key Rock, and all the persistent coals of the series are shown by their distance above or beneath it, considered as the datum plane from which all the principal members of the series—whether sandstones, limestones or coal beds—can be identified by a comparison of such relative vertical distances.

	<i>Above top of Ferr. Limestone.</i>
Millerstown Coal Bed,	305'
45'	
Freeport Upper Coal,	260'
10'	
Freeport Upper Limestone,	250'
50'	
Freeport Lower Coal,	200'
Freeport Lower Limestone, }	
70'	
Kittanning Upper Coal,	130'
45'	
Kittanning Middle Coal,	85'
45'	
Kittanning Lower Coal,	40'
40'	
Ferriferous Limestone, [20' thick.]	<i>Below base of Limestone.</i>
0'	
Scrubgrass Coal,	0'
20'	
Clarion Coal,	20'
35'	
Brookville Coal,	55'

The intervals given in this generalization have been expressed in round numbers so that they can be readily memorized. A variation from the above figures of ten, fifteen or even twenty feet will frequently be found, but the section can be applied, in a general way, to the identification of the coal beds in any part of the district.



CHAPTER V.

§ 31. *Pottsville Conglomerate, No. XII.*

This series of sandstone and shales is described in Part II of this volume, Report on the Beaver and Shenango Valleys, where all the rocks of the series are described in detail.

In Report Q, the lower limit of the section is placed at the Sharon Coal bed, the sandrock beneath it (corresponding in position with Dr. Newberry's Ohio Conglomerate) being thrown into the Cuyahoga shale.

At Sharon a conglomerate from 0' to 20' thick is found beneath the coal, and 40 feet beneath this there occurs an iron-stained sandstone, which Mr. White has named the Ferriferous Sandstone, which for the last two years I have considered as the base of the Conglomerate Series, making the total thickness from the Brookville Coal Bed down to that stratum about 300 feet. This is more than 50 feet in excess of Mr. White's "Beaver River Series."

The records of many oil wells in Butler county show a series of sandrocks—called by the drillers the "Mountain Sands,"—about 400 feet thick, which apparently must all be included in the Conglomerate Series. If we return again to Sharon we there find another sandrock lying near river level and about 100 feet below the rock I have considered the base of the series. If we include this rock in the group, we then have a total thickness of about 400 feet, or 175' of sandrock belonging to No. *XII beneath* the Sharon coal. This corresponds very well with the maximum thickness assigned to it by Prof. Newberry. The position of this Series and the Berea Grit at Sharon and New Castle will be discussed in Part II.

The accompanying generalized section, Fig. 4, compiled from data obtained in Lawrence and Mercer counties, will show the general arrangement of the series.

Homewood Sandstone, [the Tionesta	
SS. and No. XII of the First Survey,] 10' to 70',	40'
Mercer Group, shales and slates carrying two coal beds and two beds of limestone, with fireclays, iron ores, etc., 10' to 60',	30'
Connoquenessing Upper SS.,	50'
Shale with a thin coal bed and iron ore, (Quakertown coal),	40'
Connoquenessing Lower SS.,	30'
Sharon Group—Sharon shales and coal bed,	10'
Sharon ("Ohio") Conglomerate and "Ferriferous" SS.,*	75'
Shale and Sandstone—Sharon lower sandstone* at base,	150'?
Cuyahoga Shale?	

V. 4



§ 32. *The Homewood Sandstone.*

This rock is exposed in hundreds of places in the northern tier of townships, but lies under water level in the central and southern part of the district. On the Slippery Rock creek and its branches it is nearly always a very prominent stratum, jutting out of the hillsides a short distance above water level, and covering the creek bottoms

*The Ferr. S. S. and underlying rocks are considered as part of the Cuyahoga Shale. See part II, chap. II.

with large blocks. It is usually rather coarse-grained, and is always more or less stained with iron, the presence of which causes it to weather in rough gnarled blocks of great hardness.

It is finely exposed near Martinsburg, in the valley of Bear creek, where it frequently outcrops in perpendicular escarpments from 10 to 30 feet in height. It here fills a position in the measures somewhat above its usual horizon, lying only a few feet below the Clarion coal bed.

The Mercer Group, which is of much importance in Mercer and Lawrence counties, is very poorly represented in this county.

I have never seen either of the two Mercer *limestones* within the limits of the district, but both the upper and lower Mercer *coal beds* are present in some localities as impure beds of bituminous shale, usually accompanied by fireclay and bands of nodular iron ore. The latter has been worked on Bear creek, and a small quantity of it has been dug on Slippery Rock creek, but the coal beds are never of workable thickness or quality.

The Connoquenessing Sandstone is laid bare in the gorge of Bear creek, and in the cutting at the Parker Elevator, but at in no other part of the county is it above water level.

The horizon of the Sharon coal bed has been passed through in thousands of oil wells, but we have never heard of any coal being found at a depth corresponding to the place at which it should be found. The Gibson and Ecock well reports a coal bed which lies somewhat above the place of this bed, and is probably the coal or bituminous shale often found between the two subdivisions of the Connoquenessing Sandstone. This bed is seen at Donnelly Station,

on Bear creek, but is there an impure mass of bituminous shale. It probably was of the same character in the Gibson and Ecock well.

The sandrocks underlying the horizon of the Sharon coal are shown by sand-pumpings from the six oil wells watched by Mr. John H. Carll, to be rather finer grained and more micaceous than the Homewood rock. Though it is probable that they are quite massive rocks, they are seldom very hard, and good time is usually made in drilling through them.

The lower sandrocks of this series have yielded lubricating oil in small quantities on Slippery Rock creek, in Lawrence county, but no paying wells have ever been obtained in them in Butler county. In the southern part of the county the upper part of the series contains much salt water. It has a similar character in Allegheny county.

DETAILED GEOLOGY

OF THE

NORTHERN HALF OF BUTLER COUNTY.

CHAPTER VI.

§ 33. *First or southern tier of townships.*

This tier of townships embracing Muddy Creek, Franklin, Centre, Oakland, and Donegal, extends from west to east across the county just north of its central line, and is principally underlaid by the out-crop of the Freeport Group.

On the highlands, the lower portion of the Barren Measures is found, but the rocks of this series cover a very small area.

The Kittanning Group is laid bare by the erosion of Muddy Creek ; and the upper coals of the same group appear above water level on Kearn's branch of the Connoquenessing and along Buffalo Creek.

The Freeport Group, to which we should look for the main supply of coal, is, in these townships, most miserably represented by thin, slaty and sulphury beds, but rarely of workable thickness, often little better than bituminous shale, and sometimes apparently altogether wanting. The limestones of the group are seldom present.

In some localities the upper rocks of this group are apparently replaced by Barren Measures shales, as though they were either never deposited, or were eroded by an ancient denudation prior to the deposition of the latter rocks.

By reference to the contour lined map, it will be seen that these townships are nearly all occupied by high land of

rather regular outline. They contain some very fair farming and grazing land, but the absence of any good stratum of limestone will always prevent them from being made as productive as they might be were it possible to obtain for them a liberal supply of lime.

§ 34. *Muddy Creek Township.*

This township lies in the southeastern corner of the district, adjoining Lawrence county on the west, and Lancaster township on the south.

The Lower Productive Coal measures, from the top of the Ferriferous Limestone to the top of the Mahoning Sandstone, are found in fair development within its limits.

The Freeport Group has locally its usual character in the vicinity of Portersville, but its coal beds are not of workable size or quality. The Freeport Upper limestone is laid bare in the road bed in a number of places near the town, and though it appears to be of fair quality none of it is burnt or quarried.

All the fuel used in the township is obtained from the Kittanning Upper and Middle coals. These beds furnish a coal of good quality, and are usually thick enough for profitable mining.

On Muddy Creek, near the Lawrence County line, the coals underlying the Ferriferous Limestone are brought above water level, but are too thin and poor to be worked.

The section shown in Fig. 5, was compiled partly from exposures between Portersville and the Iron Bridge over Muddy Creek, and partly from data obtained on the Sunbury road two miles east of town.

At the place where the section was compiled the Freeport Upper Limestone could not be found. It is exposed in several places near Portersville, where it is apparently two to three feet thick, and overlaid by a thin coal bed, which is often very difficult to find. In the summit half a mile north from town the limestone and coal lie

about thirty feet above their outcrop near the grave yard, showing that a sharp local south dip pervades this neighborhood.

Portersville Section.

Hard massive sandstone and conglomerate.
[Mahoning S. S.] capping the highest hills (seen,) 15'

Concealed: (soft measures,) . . . 30'

Olive slate, (seen,) 3'

Red slate, 2'

Freeport Upper coal, blossom.

Concealed, 50'

Freeport Lower coal, about, . . . 1'

Concealed: Contains Freeport
Lower SS. and Upper Kit- } 130'
tanning Coal bed, }

Kittanning Middle coal, 3'

Concealed, 15'

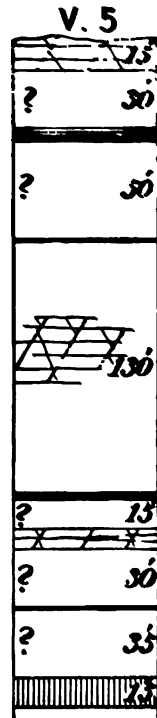
Sandstone, hard, 10'

Concealed, 30'

Kittanning Lower coal, cannel slate, blossom

Concealed, 35'

Ferriferous Limestone, 15'



The Ferriferous Limestone is exposed in a series of quarries on the north bank of Muddy Creek near the Iron Bridge. It is also exposed at Shaw's Bridge, where the stone has been quarried and a small quantity of ore stripped from its upper surface. Between Shaw's and the Iron Bridge this stratum is constantly accessible, its outcrop lying along the side hills of the valley but a few feet above water level.

The quarries at the Iron Bridge have been opened for many years, and much stone has been taken from them, but at present they are lying idle, though there is no apparent cause for this neglect, other than the reluctance of farmers to buy lime if they can possibly do without it.

Going out of Portersville by the road leading north-west

into Lawrence county, we find a coal bank opened on the farm of Mr. Bailey which measures: (Fig. 6.)

Bailey's Coal Bank.

Shaly Sandstone roof.

Soft coal slate, 1' to 2'

Coal, 2' 6" to 3'

Fireclay floor.



It is quite variable in thickness, but of rather fair quality, and is referable either to the Upper or Middle Kittanning Bed.

At the steam grist mill two miles southwest of Portersville a bed—probably the same with the one worked by Mr. Bailey—has been opened and mined quite largely for use under the steam boilers of the mill. It usually averages from 3' 6" to 4' 6" of workable coal, but the whole bed generally measures over five feet.

It was opened about ten years ago, and has been in operation ever since, and though a very large amount of coal has been taken out, there is still a large body accessible at this bank. Though it is somewhat sulphury, and the slaty partings are sometimes troublesome, the bed has given the owners a satisfactory fuel, with but little cost for mining, and none for transportation.

At the mouth of the bank a measurement was made which gave the structure shown in Fig. 7:

Grist Mill Coal Bank.

Dark blue slate roof.

Bituminous shaly slate, 0' 3" }

Coal and slate, 0' 2" }

Coal, 0' 5" }

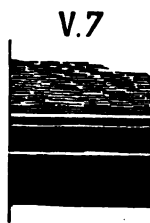
Soft parting, 0' 1" }

Coal, 1' 3" }

Bone, 0' 2" }

Coal, 2' 8" }

5' 0"



About half a mile east of the mill a band of limestone one foot thick is exposed in the road bed, at an elevation of about 100 feet above the bank. It is accompanied by a


very thin seam of coal which is either the Upper or Lower Freeport bed, but I was unable to determine to which one of these it should properly be referred.

The Kittanning Upper Bed is mined quite largely on both the east and west branches of Yellow Creek, where it is a coal of excellent quality and good thickness.

A short distance above the mouth of the East Branch it is opened at a bank on the farm of Mr. White, where the bed shows a thickness of 3' 1" as illustrated by Fig. 8:

White's Coal Bank.

Soft black slate roof.

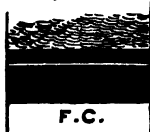
Coal,	1' 2"	} 3' 1"	
Parting,	0' 1"		
Coal (sulphury),	1' 1"		
Parting,	0' 1"		
Coal,	0' 8"		

V. 8

At the head of the East Branch, near the Portersville road, it is opened by two banks on the adjoining farms owned by Mrs. M. McConnell and Mr. W. Ralston. It is here about 75 feet higher than at the White Bank, being lifted to the northwest by a sharp rise of about 40 feet per mile. At the Ralston opening the bed exhibits the structure shown by Fig. 9:

Ralston coal bank.

Shale roof.

Slaty coal,	2"	} 2' 9"	
Coal,	6"		
Bone,	1"		
Coal,	1' 10" to 2' 0"		

V. 9

Fireclay floor.

On the Portersville road, a short distance from this bank, and about 130 feet above it, the blossom of the Upper Freeport coal was noticed in several places where laid bare by the gutter erosion. It is from one to two feet thick.

Returning to the confluence of the two branches of Yellow creek, and going up the West Branch, we see the Upper Kittanning coal opened quite frequently at banks but a short distance apart. The bed rises quite rapidly—forty

feet, more or less, in a mile—so that it passes under water level before the Prospect and Portersville road is reached.

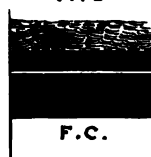
At the mouth of the W. Branch it is opened by a bank owned by Mr. Wm. Barkley, where the bed measures 3 ft. 1 in., with but one thin band of slate; showing about the same structure as the White Bank, (Fig. 8,) with the lower parting absent. About one half mile farther up the stream, it is mined by Mr. D. R. Melvin, at whose opening the bed measures: (Fig. 10.)

Melvin coal bank.

Dark Shale Roof.

Coal,	. . . . .	1' 0"	} 3' 5"
Soft parting,	. . . . .	1"	
Coal,	. . . . .	2' 4"	
Fireclay floor.			

V.10



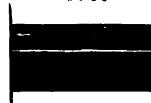
The lower bench is somewhat troubled with sulphur binders, and in some parts of the bank they are so plentiful that the value of the coal is greatly reduced.

Proceeding up the stream towards Portersville, the coal is again seen, about one half mile northwest from the latter bank, and twenty-five feet above it; in an opening on the Myers Farm. A thin bench of poor slaty coal here comes in on top of the bed, and partly at the expense of the top bench. The measurement made at this bank is shown in Figure 11:

Myers coal bank.

Slaty Coal,	6"	} V.11
Coal,	8"	
Soft parting,	1"	
Coal, (visible,)	2' 0", or more.	

V.11



Between this bank and Portersville the Upper Kittanning bed has been opened in two places near the the Portersville road, where the coal lies about thirty-five feet higher than at the former opening. Both these banks have long since fallen into disuse and the coal cannot be satisfactorily examined.

In the low land surrounding the town on the north and east, this bed has been opened and mined in small quantities

from a number of banks, among which may be mentioned those on the Stewart, Oliver, Jones, and Bailey Farms. Over this area the bed is of much poorer quality than on Yellow creek, so that these banks have gradually been abandoned, and at present nearly all the coal used in Portersville and its vicinity, is brought from the openings in the former locality.

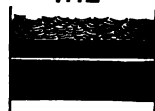
On the Isaac Moore farm, two miles northeast from town, the Middle (Upper?) Kittanning Coal was opened and worked a few years ago. The bed is said to be three feet thick with six inches of slaty coal on top, and has a slate roof and fire clay floor. The same bed is opened by Mr. William Burns, in the northeastern corner of the township, where the coal exhibits the structure shown in Fig. 12:

Burns coal bank.

Slate roof.

Coal, rather soft,	0' 10"	} 3' 0"
Slaty Coal,	. . . . .	2"
Coal, about,	. . . . .	2' 0"

V.12



The lower bench yields very good coal, but the upper bench is quite soft and dirty. The bed is undoubtedly the Middle Kittanning Coal bed, yet its structure is strikingly similar to the bed on Yellow creek which Mr. White has referred to the place of the Upper Kittanning, and suggests the query: may not the two be identical? If this be the case, then the Yellow Creek coal is the Middle Kittanning, and the Upper Kittanning was not detected in that locality.

On the Widow Gallagher farm, near the Burns' Bank, this coal is said to measure three feet, with no slaty or bony parting, though there is a layer of "very hard coal" from three to four inches thick near the middle of the bed. This "very hard coal" is probably nothing more than a seam of bony coal, and the equivalent of the slaty partings observed in other banks near by.

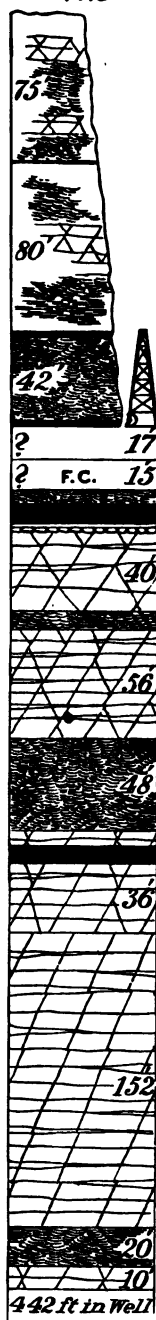
§ 35. *Franklin township.*

This township lies north from Connoquenessing and east from Muddy Creek township.

Robert Allen Well Section.

Sandstone and shale to summit,	75'
[The Freeport Upper Coal and Limestone should appear near the top of this interval, but no trace of them was seen on the road.]	
Freeport Lower Coal blossom, . .	1'
Shale and Slate with S. S. near middle,	80'
Kittanning Upper Coal,	3'
Sandy Shale,	42'
Kittanning Middle Coal, [Well mouth,]	3'
WELL RECORD, . . Conductor,	17'
Fireclay?	15'
Shale,	8'
[Kitt., Lower,] . Coal,	10'
Fireclay,	2'
Leadstone,	2'
[Ferr. Limeat base,] White Sandstone, }	40'
Shale,	10'
[Homewood S. S.] Black soft SS. }	56'
[Mercer Group,] Shale,	48'
White soft S.S. }	8'
[Mercer?] [?] . Coal,	8'
Black S.S.,	36'
Mountain Sand,	152'
Shale,	20'
Black S.S.	10'
Gas and oil,	660'
S.S. heavy flow of salt water,	1040'
to	1090'
Depth of well,	1094'

Beaver River series, No. XII.



The lowest rock exposed within its limits is the Middle Kittanning Coal Bed, which lies at water level on Muddy Creek. In the high dividing ridge near Prospect, the lower part of the Barren Measures is caught in the highest summits, but it contains nothing valuable. The township is not very well supplied with coal. Both the Upper and Middle Kittanning beds are of workable size near Muddy Creek, but their available area is quite small, as they soon sink below water level, approaching the eastern line of the township.

The detailed section, of 219 feet, shown in Fig. 13, was compiled from exposures on the Prospect road, a short distance north from Muddy Creek. It is supplemented by a record of the Robt. Allen Well, which was unsuccessfully drilled for oil some years ago. The Ferriferous Limestone is not noted in this record, but should have been found in the interval noted "White sandstone, 40 feet." It may be absent, but was most probably confounded with the sand rock, and included in it by the driller.

Two coal beds of fabulous size are reported in the above well record: the first, which is undoubtedly the Lower Kittanning bed, will probably prove to contain not more than three or four feet of workable coal; the second, or eight foot bed may be nothing more than a stratum of black slate, bituminous shale, or impure coal. It belongs to the Mercer (?) Group of inter-conglomerate beds.

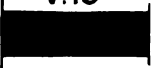
The Kittanning Middle Coal is opened and mined on the farm of Mr. Robert Allen in close proximity to the old well. A measurement of the bed near the mouth of the bank gave:—Fig. 14.

Robert Allen Coal Bank, (mouth).

Soft Coal,	1' 0"	} 2' 7"	V. 14
Hard Coal,	1' 7"		

At the head of the entry, the coal is all hard and good, and averages 2' 4" in thickness. A second measurement, made midway between the mouth of the bank and the most distant workings, shows:—Fig. 15.

Robert Allen Coal Bank, (inside).

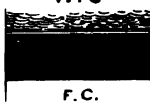
Poor Coal,	3"	} 2' 2"	V.15 
Soft Coal,	8"		
Good Coal,	1' 3"		

This bed presents the rather unusual feature of a coal of workable size, containing no partings of slate or bone.

On the J. W. Campbell farm, near Muddy Creek, the same bed was opened at a bank nearly at creek level and was worked for several years, but the bank has long since fallen shut, and the coal cannot now be seen. At the time of collecting the data for this report, a bank was being opened on the John Gallagher farm. The entry had only been driven in about fifteen feet, but the outcrop coal visible indicated the presence of a good bed, with no perceptible band of slate, bone, or pyrites. It measured about 2' 10".

At Baker's Bank, near Mr. Allen's place on the north side of the creek, the bed is of quite good quality, and measures from 2' 6" to 2' 8". (See Fig. 16.)

Baker's Coal Bank.

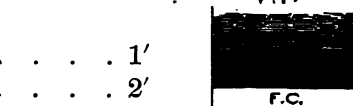
Shale roof.			} 2' 7"	
Slaty Coal,	3"			
Soft Coal,	6"			
Good Coal,	1' 10"			

Fireclay floor.

This bank is well drained and is in good running order.

About a mile and a half northwest from Prospect, on the farm owned by Mr. J. Y. English, an unsuccessful attempt has been made to open the same bed, but the coal dipped so rapidly into the hill, that the proposed mine was drowned out before the entry had been driven in two rods. At the outcrop the bed consists of (See Fig. 17):

English Coal Bank.

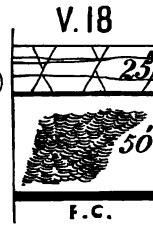
Slaty shale roof.		
Soft Slaty Coal,	1'	
Coal, variable, about	2'	
Fireclay floor.		

Fireclay floor.

The Freeport Sandstone outcrops on the hillside about fifty feet above the coal, giving the section shown in Fig. 18.

Section near Prospect.

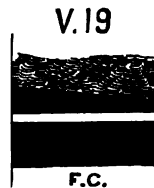
Freeport Sandstone ; hard, massive, and rather coarse,	25' (seen)
Coal blossom, upper Kittanning bed,	1' (?)
Concealed—shale,	50'
Kittanning Middle Coal,	3'
Fireclay.	

§ 36. *Kittanning Upper Coal. (Franklin T.)*

This bed has been opened and worked at a number of banks on the Wm. Wigton and Saml. W. Shannon Farms, near Muddy creek, about one mile east from Mr. Allen's residence, but most of them have fallen shut, and those still open were too full of water to allow a proper examination to be made. The bed is claimed to measure from four feet to four feet ten inches, with a central parting of slate from two to ten inches thick. At the mouth of one of the banks, which was partly accessible, the coal gave the measurements shown in Fig. 19.

Wigton and Shannon banks.

Shale roof.	
Coal,	0' 7" to 1' 4"
Slate,	0' 6"
Coal,	1' 11"
Slate,	0' 2"
Fireclay floor.	



In the surrounding hillsides frequent attempts have been made to open this bed, but it seems to lie in an irregularly shaped "pot," and is thin and poor in all of the places where its outcrop can be seen. A short distance northwest from the banks, an entry was driven into the same hill for quite a long distance, but the bed was usually only a few inches thick, sometimes swelling to a maximum of two feet, and was of poor quality, being very dirty and filled with thin seams of slate.

The Kittanning Middle Coal underlies the above described bed, about forty feet, and is opened on the farm of Mr. G. J. McCandless, where it shows :

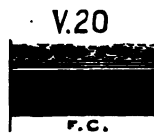
McCandless coal bank.

Shale roof.

Slate, 0' 6"

Coal, 2' 4"

Fireclay floor (†).



but is rather pyritous and slaty, and has not been worked for several years.

The following section, shown in Fig. 21, exhibits the relation of this coal to the one overlying it.

McCandless section.

Freeport Lower Sandstone, hard and

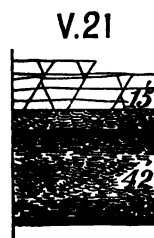
massive, (seen,) 15'

Shale, 10'

Kittanning Upper Coal, 4'

Shale and Slate, 42'

Kittanning Middle Coal, 3'



About a mile and a half east by north from the Wigton Banks, the Upper Kittanning Coal has been opened on the place owned by Mr. W. N. McCandless, but the bed was very thin, and not worth working.

The Freeport Upper Coal and Limestone should be found in the hills near Prospect and Mount Chestnut, but excepting over a small area north from the former place, they are apparently absent.

Half a mile north from Prospect the limestone is detected by scattered fragments from its outcrop, and is probably about two feet thick. Its overlying coal bed outcrops rather faintly on the steep hillside west of the main road, but is probably too thin to be of any value.

§ 37. Oil Wells. (*Franklin T.*)

Within the limits of this township, several wells have been unsuccessfully drilled for oil, but no detailed or even fragmentary reliable records of them can now be obtained.

The Nesbitt Well on the Hindman Farm, and the McCandless Well near the swamp were both drilled in 1877.

Nothing could be learned in regard to the latter, but the following imperfect record of the former, was kindly furnished by Mr. Robert Allen.

The Nesbitt oil well.

This well is situated on the flat of a small tributary emptying into Muddy Creek from the south, and is about on a level with the Middle Kittanning Coal bed. The Ferriferous Limestone should have been reached at a depth of between 70 and 90 feet, but it is reported in the well at 215 feet. If any limestone was found at that depth, it must have been one of the Mercer Limestones. It seems probable that the drillers of this well have mistaken the bed of "soft white Sandstone 8 feet" thick, noted at a depth of 208 to 216 feet in the Robert Allen Well (see page 42) for the Ferriferous Limestone. In the Smith Well, (see Brady township) which starts about 145 feet above the Nesbitt Well, the limestone is reported at 230 feet. $230' - 145' = 85'$ as the depth at which we should expect to find it in the latter well. From these facts it is certain that the Ferr. Limestone could not have been found at the depth stated in the record, thus:

Nesbitt well record.

Limestone, at	215'
Mountain Sand, at	375'
First Sand, at	1090'
Second Sand, at	1275'
Third Sand, at	1375'

Cased at 510 feet. Total depth of well 1492'.

Mr. Allen also gives the following record of the McCandless Well, drilled by Messrs. Satterfield and Taylor, situated above the swamp in Franklin (or Centre ?) township.

McCandless oil well record.

Limestone, at	235' to 250'
Mountain Sand, at	470' " 630'
First Sand, at	1130' " 1180'
Second Sand, at	1370'
Depth of well,	1500'±

"Heavy vein of salt water found in the First Sand."

The preceding records were furnished by Mr. Allen just

as he had received them from other parties, without any alterations, and any inaccuracies that they may contain are not to be attributed to him. He has devoted much time to obtaining these and other oil well records, levels, etc., and feels very keenly the difficulty of obtaining any accurate information of this kind.

§ 38. *Centre Township.*

This is an aptly named township, as it lies in the centre of the county, with two townships west and two east of it, three north and three south of it. It is directly east from Franklin and north from Butler township.

In its southern and central portions the lower rocks of Barren Measures are caught in the hilltops, but are barren of workable coal beds.

The blossom of a coal, which is probably the representative of the *Brush Creek Coal bed*, is often seen on the road-sides at an elevation of nearly a hundred feet above the Upper Freeport Coal, but the bed is always of poor quality and too thin to be valuable. No trace of its accompanying bed of limestone was observed, but it may be present, though it is probably quite thin.

The Mahoning Upper Sandstone (Buffalo S. S. of report Q) is seldom a massive rock, and its horizon is usually filled with tough sandy shale, or argillaceous sandstone.

The Freeport Group occupies every hillside in the township, and,—with the exception of a small area on Kearn's Branch of the Connoquenessing,—always extends down to water level in the streams. As this group is generally of poor development throughout the township, the latter is not very well supplied with coal.

§ 39. *Unionville Coal Banks. (Centre T.)*

About three quarters of a mile east of Unionville, are the entries of two coal banks in close proximity to each other, which have been in operation for over twenty years. One of these banks is owned by Mr. Daniel Heck, and the other is on the farm owned by Mr. Eli G. Eagle.

The coal is of excellent quality, and will compare favorably with any of the coals of the Lower Productive Coal Measures. It is a hard, black, lustrous, rich looking coal, but in some parts of the bank is somewhat pyritous. The middle bench contains little sulphur, but both the upper and lower benches in places carry so many sulphur binders, as to materially impair its value. The following analysis was made by Mr. McCreath from a sample taken from the middle bench:

Water,	2.110
Volatile matter,	37.570
Fixed carbon,	51.248
Sulphur,	1.894
Ash, (cream color,)	7.178
	<hr/>
	<u>100.000</u>
Coke, per cent.,	60.320

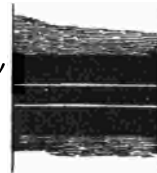
Both of these banks have been worked a long distance into the hill, and unfortunately in the same direction with the dip of the bed, [*i. e.* to the south,] necessitating deep drains. In some places these have been dug into the underlying fireclay to a depth of ten feet without reaching its bottom.

Heck coal bank.

Slaty shale roof.

Coal,	1' 6"	} 4' 2"
Slate,	0' 1"	
Coal,	1' 0"	
Slate,	0' 1"	
Coal,	1' 6"	
Slate,	1' 0"	

V.22



Fireclay floor, quite hard, over 10 ft. thick.

A measurement of the bed made in the entry of the Heck Bank gave the structure exhibited in Fig. 22.

The above measurement gives 4' 2" as the total thickness of the bed, but it does not retain this thickness over a very large area. Search has been made for the bed at many places in the vicinity of the banks but has always resulted

unsuccessfully. At some places no trace of the coal could be found, and at others it was but a few inches thick.

The total thickness of the bed in the banks does not vary more than three or four inches either above or below four feet. The following generalized description of the bed was furnished by the man in charge of the banks:

Heck and Eagle Coal Banks.

Slaty shale roof.

Coal,	1' 4" to 1' 8"
Slate,	0' 0 $\frac{1}{4}$ " to 0' 1"
Coal,	0' 11" to 1' 2"
Slate,	0 0 to 0 7"
Coal,	0' 9" to 1' 6"

The coal mines in good, large pieces, but after lying exposed for a short time, that portion which came from the upper and lower benches, soon crumbles into small fragments. This is occasioned by disintegration caused by the presence of thin laminæ of pyrites.

A small quantity of coke has been made from it for use in the foundry at Prospect. Culled lumps are used and the coke made is of very fair quality, but might be greatly improved by crushing the coal and washing out the sulphur preparatory to coking.

In the absence of any good geological horizon from which to work, it is impossible to correctly place this coal in the series. It seems most probable that it is either the Upper Freeport or Millerstown Coal bed, but it may possibly be the Lower Freeport bed. About three fourths of a mile east from the banks, and from forty to fifty feet below them, a bed of limestone is exposed in the stream bed. This is undoubtedly either the Upper or Lower Freeport Limestone, but we have no means of determining its dip from the place at which it is exposed to the coal banks. The same stratum is found on Mr. McBride's farm in Franklin township, a short distance west of Unionville.


In the southwestern part of the township, in a gorge formed by a branch of the Connoquenessing Creek, there are three coal banks opened on a bed which apparently lies much higher than the Upper Freeport coal, and is prob-

ably either the Millestown or Brush Creek coal bed. About two feet of rather good coal is visible in one of these banks above water level in the drain, with fireclay beneath it, and a rather soft shaly roof. No coal is being taken from this bed at present.

On Kearn's Branch of the Connoquenessing, in the eastern part of the township, several banks have been opened on the Upper Kittanning (?) Coal bed. Those owned by Mr. David Birch have been worked for many years, and are now a long distance in the hill. At the bank owned by Mr. Henry Leibold, which has just been opened and is very close to the Birch Banks, the coal measures :

Leibold coal bank.

Shale roof :—

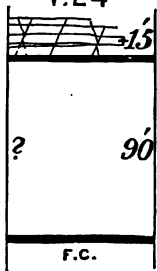
Draw slate,	3"	} 2' 11"	
Coal,	9"		
Slate,	2"		
Coal,	1' 0"		
Soft partings,	—		
Coal,	9"		

Fireclay floor.

This bed yields an excellent coal, and after getting under sufficient cover, mines in blocks of good size.

The Freeport Lower coal has been found in the hills on both sides of the stream. It is said to be about two feet thick, and is overlaid by a hard massive sandstone which juts out in rough escarpments on both sides of the creek. This coal has also been opened on the Hulings' farm. Fig. 24 shows the relative position of these two coal beds, and the overlying sandrock.

Kearns branch section.

Freeport Upper Sandstone, hard and massive,	15'	
Freeport Lower coal,	2'	
Concealed, (?)	90'	
Kittanning Upper coal, (?)	3'	
Fireclay.		

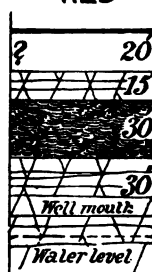
On the McCandless Farm, near the Butler and Sunbury road, in the northern part of the township, a well was drilled for oil about four or five years ago. No information no oil was obtained. The well mouth is about ten feet could be gathered concerning it, further than the fact that above water level, and is near the base of the Freeport Sandstone. The limestone therefore should have been found at from 100 to 150 feet and the Butler "Third sand" at 1300 to 1350 feet.

In the hill above the McCandless well, the rocks shown in Fig. 25, were measured :

McCandless farm section.

Coal blossom,	thin.
Concealed,	20'
Hard massive Sandstone,	15'
Shale,	30'
Hard massive Sandstone,	30'
Well mouth,	—
Sandstone to water level,	10'

V.25



The coal blossom observed near the hill-top may be the Freeport Upper bed, but in the absence of any auxiliary proof, its identification is extremely uncertain.

OAKLAND.

§ 40. Oakland Township.

This township lies east of Centre and north of Summit townships. It is quite poorly supplied with coal, as the Upper Freeport sub-group, from which we should expect a good supply, has a very poor developement within its limits. It is also unfortunate in being—so far as is known at present—barren of any oil producing territory. The "Fourth Sand" oil belt just reaches its northern line, but does not cross over into the township, and the Millerstown and St. Joe "Third Sand Belt" just skirts its eastern boundary line.

Many wells have been drilled in this township south and southwest from Greece City in search of a prolongation

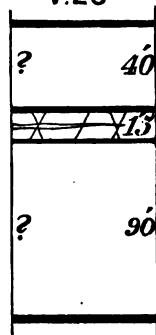
southward of the "Fourth Sand Cross Belt," but these have all resulted unsuccessfully. In some places an excellent sand of good thickness is reported to have been found, but no oil in paying quantities has ever been obtained from it.

The section shown in Figure 26 was compiled partly from exposures on Kearn's Branch south of Boydstown, and partly from data collected on the road from Boydstown to Sunbury.

Boydstown Section.

Freeport Upper Coal,	3'
Concealed,	40'
Local Coal (L. F. C. ?)	2'
Sandstone—Freeport Upper ?	15'
Freeport Lower Coal (local bed ?)	thin.
Concealed, about	90'
Kittanning Upper Coal,	3'

V.26



The Freeport Upper Coal is opened on the place of Mr. Jacob Rider, close to the Concord township line. The original opening has been shut for some time past, and Mr. Rider has just opened a new bank on the opposite side of the run. He says that the bed consists of, (See Fig. 27.)

Rider coal bank.

Shaly slate roof—very poor.

Coal,	1' 5"	} 3' 1"
Slate,	0' 2"	
Coal,	1' 6"	

Fireclay and slate floor.

V.27



This bed yields a coal of fair quality, but it mines in rather small pieces. In the bottom of the hollow below the bank, the Lower Freeport Coal has been found, but it is too thin to be of any value.

The bank in the same vicinity, owned by Mr. Whitmire, is opened on a coal which apparently lies between the Upper and Lower Freeport beds, but which may possibly be the same with the latter coal bed. If this be the case, then the bed changes its horizon fifteen to twenty feet in a very short distance. In Mr. Whitmire's Bank the coal is of fair qual-

ity, but rather too thin for profitable mining. The bed measures: (See Fig. 28.)

Whitmire coal bank.

Shale roof.

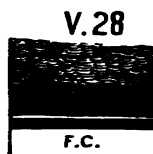
Soft and Slaty Coal, 6"

Coal, 1' 2"

Soft parting, thin.

Coal, 6"

Fireclay floor.



The Millerstown (?) Coal Bed, which occurs in the horizon of the Mahoning Sandstone, is opened in a bank on the Hutchinson farm, one mile southeast from Boydstown, but the opening has been closed for some time, and the bed could not be thoroughly examined. The outcrop coal at the mouth of the entry shows about two and a half feet of very fair coal, with a fracture somewhat resembling that of a semi-cannel bed. It is quite free from sulphur.

The Freeport Upper (?) coal has quite a fair local development in the same neighborhood, and has been opened and mined on Mr. Monnie's place, fifty feet vertically below the Hutchinson bank. It is possible that this bed may be the equivalent of the Lower Freeport Coal, in which case the Hutchinson coal would be the same with the Upper Freeport bed.

The Upper Kittanning coal in Oakland T.

On Kearn's Branch of the Connoquenessing in the southwestern corner of the township, this coal has been opened and worked by several banks. The bed is tolerably free from sulphur, is of fair quality and measures from 2' 10" to 3' 2" in thickness. It lies at water level, and in some instances the banks upon it have been much troubled by flooding during high water.

For quite a considerable distance along the creek, the coal keeps above water level, and has been mined quite largely, but most of the banks are south of the Oakland township line, and lie in the district reported upon by Prof. White in his Report of Progress, Q.

DONEGAL.

§41. *Donegal Township.*

This is the most easterly township of the first tier, lying east from Oakland and north from Clearfield townships; and adjoins Armstrong county along its eastern line.

It lies on the eastern side of the great divide between the Allegheny and Beaver waters, all its streams being tributary to Buffalo creek or its branches.

Oil Territory.

The great "Third Sand Oil Belt" runs through it about S. 22° W. from where it enters the township north of Millerstown, to St. Joe and Carbon Centre [Thompson's Corners], and has yielded a large amount of oil. East of Millerstown a short distance, is the celebrated "Eastern Belt" which probably is producing its oil from the Fourth Sand. It seems to be but a local patch of productive sand, and cannot be traced continuously as an oil-bearing rock, either very far to the south or to the north of where it was first discovered. Along the Third Sand Belt, the Fourth Sand is characteristically a "gas sand." The Delameter and Burn's gas wells, and many other wells in the same locality, are producing their gas from this sandrock. The Thompson well at Carbon Centre also found its gas at this horizon in a good pebbly sand. A record of this well was kindly furnished me by Mr. S. McGara of Martinsburg, and will be found reprinted from Report I.I, in Chap. X this report.

§ 42. *Millerstown Coal. (Donegal T.)*

As the name of this bed indicates, it is found in typical development at and around Millerstown.

It occurs from 295 to 315 feet above the Ferriferous Limestone, and from 35 to 55 feet above the Upper Freeport Coal Bed.

In the Mead well near St. Joe—see Chap. X—it is reported at 300 feet above the Limestone, and in the Jenkins well near Greece City in Concord township—see Chap. X—

at 305 feet above the same stratum. The latter well also records the presence of the Brush Creek Coal bed.

In the vicinity of Millerstown, and between that town and Karns City, the bed is mined quite largely for use at the wells, and usually consists of two benches; the upper one being poor, slaty, laminated coal, and the lower one of workable quality.

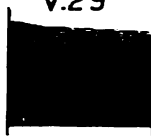
One mile west of town two banks are opened upon it, a few feet below railroad level; it measures:

Karns City coal banks.

Slaty coal roof.

Slaty laminated coal,	1' 5"	} 4' 2"
Coal—(seen,)	2' 9"	

V.29



In some parts of these banks the bed yields quite good coal, but it is generally very poor. The smut of the Upper Freeport bed was found 35 or 40 feet below the banks, and an attempt has been made to open it, but the bed proved worthless.

At the Forquer Bank, a short distance south of Millerstown, the bed shows 3' 6" to 3' 9" of quite good coal, and is remarkably free from slate bands. It has a soft shale roof, which is in such bad condition that the bank has nearly fallen shut. *The bed here dips to the north.*

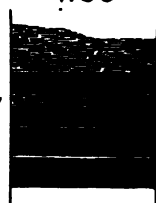
About half a mile south of this bank the Millerstown bed is again opened in the Conway Bank, where it consists of four benches, and has a much greater thickness than at the Forquer opening. Near the mouth of the entry the bed exhibits the structure shown in Fig. 30.

Conway coal bank.

Slate roof.

Poor coal,	1' 0"	} 5' 10"
Slaty coal,	0' 9"	
Coal,	1' 0"	
Soft parting,	0' 0½"	
Coal, (good,)	1' 5"	
Slate,	0' 1½"	
Coal, (fair,)	1' 6"	

V.30



Most of the coal mined from this bank is taken from the two lower benches, and is of very fair character. This bank

is much higher than the Forquer Bank, showing that between the two openings *the coal has a north dip.*

The Freeport Upper Coal is a very poor bed in nearly all parts of this township, and can never be looked to for a supply of good fuel. It has been opened at several places in the south-eastern part of the township, but is always quite thin and of miserable quality.

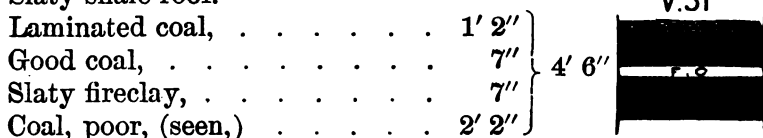
Mr. George Rogers has a bank opened upon this bed, which is worked at intervals. The bed here yields better coal than can be expected from it in other localities.

On both branches of Buffalo creek the Upper Freeport sandstone is a hard massive rock, outcropping boldly along the streams, and covering the surface in some places with many large irregularly shaped blocks. It locally shows a strong dip to the south-west, sometimes amounting to thirty feet in half a mile, which soon carries it down into the Bradys Bend synclinal axis, which crosses the south-eastern corner of the township, near the farm of Mr. John Rogers.

Near Mr. O'Brien's house, in the eastern part of the township, a bank has been opened on the Upper Freeport bed, but the coal is so poor that it hardly pays for the digging, and little is now mined. It is very variable in thickness, but the following measurement, shown in Fig. 31, will give a good idea of its structure:

O'Brien's coal bank.

Slaty shale roof.



One mile south from this bank the bed consists of an utterly worthless mixture of slate and slaty coal.

§ 43. *Millerstown Anticlinal. (Donegal T.)*

This anticlinal roll crosses the township in a line probably parallel to the Bradys Bend Synclinal Axis, passing a short distance south-east of Millerstown, and crossing the "Third Sand Oil Belt," near the Diviner Farm.

Its north dip amounts to about forty feet, and extends north-west and south-east a distance of about three fourths of a mile. It is shown both by oil well records and elevations, and by the dip of the coal beds in the vicinity of Millerstown.

CHAPTER VII.

§ 44. *Second tier of Townships.*

This tier, comprising Worth, Brady, Clay, Concord, and Fairview lies next north of those described in Chapter VI.

The formations outcropping in this tier of townships, include the rocks of the Lower Productive Coal series from the Mahoning sandstone down to the top of No. XII—the Homewood Sandstone.

The latter rock is above water level only in the valley of the Slippery Rock, no other stream cutting deep enough to expose it.

The Kittanning Group occupies the hillsides, and presents at almost every locality one or two good beds of coal of workable size. The Lower Kittanning Coal and Ferriferous Limestone are only found above water level in Worth and Brady townships. The former is but seldom thick enough to be mined, and is often difficult to find. Though the Ferriferous Limestone underlies a large area in these two townships, it is not often exposed, and little of it has ever been quarried or burnt.

The Middle and Upper Kittanning coal beds are presistent as workable beds over quite a large area, and nearly always yield a gas coal of excellent quality, often quite free from pyrites.

The Freeport Group of coal and limestone is caught in all the high land, but only contains workable beds in a few isolated patches, where it has a good *local* development. Its best representation is found at Sunbury, where both the coals of this Group are workable beds.

WORTH.

§ 45. *Worth Township.*

This township adjoins Lawrence county on the west, and lies north of Muddy Creek township. In its northern por-

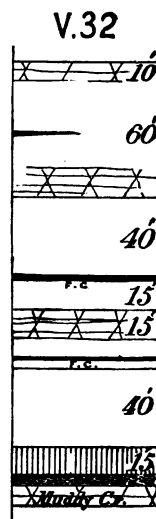
tion is the broad, gentle valley of the Slippery Rock, the south side of which rises quite gradually until the summit is reached. Muddy Creek Valley is a much sharper cut, with its north slopes often very steep, but contains broad bottom lands in the creek bottom.

The Freeport Group which is found in the high lands of the divide between these two streams, is of little value; but the Kittanning Group carries coal beds which insure, for many years to come, a bountiful supply of excellent fuel.

By reference to the contoured map it will be seen that the Ferriferous Limestone is accessible over a large area in this township. Its outcrop in the northern part of the township, usually occurs on ground where the side slopes are quite gentle, enabling one to quarry a large amount of the stone by removing but little surface earth. Its horizon is, however, often quite difficult to find, as there are, in that part of the township, frequent beds of drift, which obscure the topographical evidences of its presence.

Iron Bridge Section.

Sandstone (top exposed,) "say,"	10'
Concealed—with thin coal,	60'
Sandstone hard and gray,	10'
Kittanning Upper Coal,	absent.
Concealed,	40'
Coal—Kittanning Middle,	3'
Fireclay,	} 15'
Concealed,	
Coarse massive Sandstone,	(about) 15'
Concealed,	10'
Coal—Kittanning Lower,	(about) 1'
Fireclay,	(about) 5'
Concealed,	40'
Ferriferous Limestone,	15'
Coal,	reported.
Sandy shale,	5'
Sandstone, micaceous to level of Muddy Creek,	10'



The section shown in Fig. 32, was compiled from ex-

posures in the southern part of the township, on and in the vicinity of the road running north from the Iron Bridge over Muddy Creek. It compares very satisfactorily with the one compiled south of Muddy Creek, on the road to Portersville. [See Fig. 5.]

The Ferriferous Limestone is exposed at the Iron Bridge on Muddy Creek in a number of quarries to which reference has already been made in the description of Muddy Creek township. It is of bluish gray color, yielding a very fair lime, and is from twelve to fifteen feet thick. From this point westward to Shaw's, it is constantly accessible, lying but a few feet above water level.

The Kittanning Lower Coal bed was seen outcropping on the road a short distance north of the creek, but the bed is too thin to be of much value. It lies about forty-five feet above the Limestone.

The Kittanning Middle bed has a thickness of about three feet in this locality, but the Upper Kittanning bed could not be detected. It is probably absent, but may be represented by a very thin seam which has escaped observation. The former bed is opened at a large number of banks north of Muddy Creek. Near the creek, the bed ranges from 2' 9" to 3' 0" in thickness and is of fair quality, but going northward from the stream, it swells to a size of 3' 0" to 3' 6", and improves as much in quality as it does in thickness.

At the old Pisor Bank in the southeastern part of the township this bed (Middle Kittanning) is said to measure 3' 6", but only 3 feet of it yielded a marketable coal. In the bank on the Widow Vogan farm, north from the latter opening, the coal measures three feet and is all of good quality.

In an old bank owned by Mr. William Hockenberry, a "horseback" is said to completely cut the coal off. This is a very unusual feature for this bed to show, it being generally quite free from such irregularities.

At the opening on Mr. John Book's place, a mile and a half north from the Iron Bridge, it measures, (Fig. 33.)

The bed is tolerably free from sulphur and is of good quality throughout the bank. It is also opened and worked

in the same locality by the Drorbough, Campbell and Studebaker Banks, in which the coal ranges from 2' 6" to 3' 6".

Book's coal bank.

V.33

Slaty slate roof.

Soft poor coal, 6' }
Coal,—one thin parting, 3' 0" } 3' 6"

Fireclay floor.

At the last named bank, it is of exceptionally good quality, contains but little sulphur and mines in good hard blocks of large size. It usually consists of three benches, as shown in Fig. 34.

Studebaker coal bank. (Kitt. Mid. Coal.)

Coal, 1' 2" }
Slate, 2" }
Coal, 1' 6" } 3' 4½"
Soft parting, ½" }
Coal, 6" }
Fireclay (seen), 3' 0" }

V.34

F. C. + 3

Mr. McCreath has made an analysis of a specimen taken from the middle bench of this bed [Middle Kittanning] with the following result:

Water, 2.270
Volatile matter, 40.990
Fixed carbon, 46.794
Sulphur, 1.871
Ash, (grey,) 8.075

100.00

Coke, per cent., 56.740

McCracken Coal Bed.

Slaty shale roof.

Coal, 1' 3" }
Slate, 1" to 2" }
Coal, 1' 6" } 3' 5"
Soft parting, ½" to 1" }
Coal, 0' 6" }

V.35

F. C.

Fireclay floor.

A short distance north from the Studebaker bank, the

same bed is opened by Mr. McCracken where the coal measures: [See Fig. 35.]

This measurement shows a remarkable agreement with the preceding one; the coal also is very similar to that in the Studebaker opening. The bed here lies from 75 to 80 feet above the Ferriferous Limestone, the outcrop of which may be seen at several places in this vicinity near stream level. A small coal bed is said to exist immediately beneath the limestone, but I did not see any exposure of it. A short distance west from Mr. McCracken's house, in Lawrence county, this bed has been opened and mined, and measures about two feet.

§ 46. *Harrisville Anticlinal, (Worth T.)*

At the Studebaker bank the coal lies about fifteen feet *above* the McCracken opening, proving that a strong *north dip* pervades the measures in this locality. This is occasioned by the Harrisville anticlinal axis which runs through the township in a southwesterly direction. Its crest line passes close to Mechanicsburg.

The north dip of this flexure can readily be detected in the limestone, which here lies thirty feet higher than at the quarries near the mouth of Wolf Creek, and in a small hollow south of Black's Run it lies over fifty feet above the same quarries. The exposure near Black's Run is probably on, or very close to, the crest of the anticlinal.

In simply crossing the Slippery Rock, from the exposures along its south bank to the quarries at Wolf Creek, a north dip of thirty-five feet is detected. The mouth of Wolf Creek probably lies very near the center of the synclinal trough.

The axis is also seen on Slippery Rock Creek between Eckert's Bridge and Rose Point, where a north dip is quite noticeable in the Ferriferous Limestone and Conglomerate.

The section of 338 feet shown in Fig. 36, was compiled in going northward from Shaw's Bridge over Muddy Creek, to the farm of Mr. George Vogan.

Shaw's Bridge Section.

Mahoning Sandstone, hard and massive, in summits,	20' to 30'
Shale,	20'
Coal, Freeport Upper, reported $2\frac{1}{4}'$,	2'
Shale,	22'
Sandstone, hard and massive,	20'
Shale, with some shaly SS.,	65' (?)
Coal blossom, reported $1\frac{1}{4}'$,	1'
Shale,	60' (?)
Sandstone, hard and massive,	20'
Shale,	20'
Kittanning Middle coal,	3'
Concealed, (about)	75'
Feriferous Limestone at Muddy Creek,	10' (?)

The total measurements of the above section should be reduced about thirty feet, to eliminate the error caused by the south dip of the rocks. Most of this correction should be thrown off the 60 and 65 foot intervals.

No trace of the Upper Freeport Limestone was observed; nor have I found any indications of it in any other part of the township. The smut of the Upper Freeport coal is seen near the road summits in several places, and attempts have been made to mine the bed, but it was found to be very impure and thin; and in the presence of such a coal as the Middle Kittanning bed, it would be folly to persist in working it.

The latter bed is opened and worked on the Wm. Currie farm, one mile and a half north from the old Pisor bank, where the coal exhibits the structure shown in Fig. 37. The upper bench is quite slaty, but the lower bench yields a very good coal:

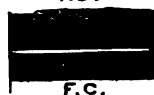
Currie Coal Bank.

Slaty shale roof.	
Slaty coal,	1' 5"
Slate,	1" to 2"
Coal,	1' 6"
Fireclay floor.	

V.36



V.37



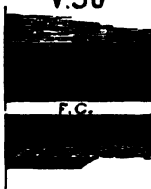
§ 47. *The Currie Local Coal Bed.*

In the hill above the bank just described, and eighty feet over it, Mr. Currie has opened a very peculiar bed of coal, which measures about six feet, and is divided into four benches as shown in Fig. 38. Search has been made for this bed on many other farms in this vicinity, but they all failed to find a workable bed at this horizon. On the Sutliff farm it is said to be an almost worthless mixture of cannel coal, slate, and bituminous coal, with slate bands running through all parts of the bed.

Mr. Currie's opening on the bed has almost fallen shut, but the bed can still be seen, and measured.

Currie Local Coal Bed.

Blue slate roof.

Cannel coal,	1' 3"	} 5' 3"	
Mixed cannel and bituminous coal,	3"		
Good coal,	1' 6"		
Fireclay,	9"		
Coal,	1' 6"		
Slate, (reported)	8"		
Coal, found in drain,	—		

The cannel bench is only of medium quality, but the underlying bituminous coal is quite free from pyrites, and is reported to be an excellent smithing coal. Going into the drift a short distance, the nine inch seam of fireclay quickly thickens to eighteen inches and becomes quite hard and sandy. The bench beneath it consequently had to be abandoned, as it did not pay to take out fifteen or eighteen inches of hard material to recover only the same thickness of coal. The drain cuts into a dark slate underlying this lower bench. It is about eight inches thick, and rests upon another bench of coal, the thickness and quality of which are unknown.

Currie Vertical Section.

This bed resembles in its general character and position, the "Eichenaur Local Coal" of Report Q, page 122, lying in the horizon of the Freeport Sandstone.

The section shown by Fig. 39 will serve to show its position.

sition with reference to the overlying and underlying strata.

Currie Section.

Hard Massive [Mahoning] Sand-	
stone,	10 to 20'
Concealed,	30'
Coal—Freeport Upper Bed (?) . . blossom.	
Concealed,	80'
Currie's Local Coal,	8'
Concealed,	80'
Kittanning Middle Bed,	3'
Concealed, (about)	80'
Ferriferous Limestone,	15'

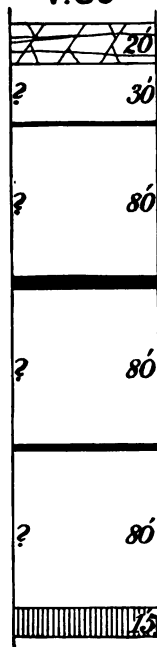
Its place in the series is seen to be about forty feet above the Upper Kittanning Coal, and about thirty feet below the Lower Freeport bed, but neither of these coals are exposed in the vicinity of Mr. Currie's opening, and they both are most probably very thin worthless beds in that locality.

Humphrey Section.

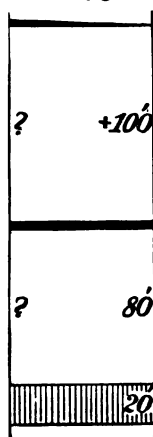
Coal blossom on hill [Lower Free-	
port]	0' to 4'
Concealed,	100'±
Kittanning Middle Coal,	3'
Concealed (about)	80'
Ferriferous Limestone,	20' (?)

Returning from Mr. Currie's bank, and going northwest along the hill, the above section [See Fig. 40] was compiled from exposures on the road just north from Mr. James Humphrey's house. Near the hill-top a coal blossom, which lies at about the horizon of the Lower Freeport Bed, is seen at several places on the road. It has been pretty thoroughly tested by a number of diggings and proves quite variable in thickness, in some places measuring four feet, and in others being represented by a very few inches of bituminous slate.

V.39



V 40



On the farm owned by Mr. Porter Davis, adjoining Mr. Humphrey's place, a bank is opened and worked in the hollow near the school-house. This is the Middle Kittanning bed, and measures [Fig. 41.]

Davis Coal Bank.

Shale roof.

Slaty Coal,	1' 0"	} 3' 3"
Slate,	1"	
Coal,	2' 2"	

V. 41



The coal is rather too pyritous to give satisfaction, but does very well for local use.

The Ferriferous Limestone was passed through in drilling a water well one half mile north from Mr. Humphrey's, and is reported to be about twenty feet thick, but as this is quite an unusual thickness for this stratum in western Butler, it seems probable that the measurements were imperfectly made. It is exposed in nearly all of the hollows that run back between the hills on the south side of Black's Run, but has not been quarried much, and there are no exposures showing its total thickness. In the ravine, a short distance northeast from Mr. Humphrey's, there is a quarry which has been in operation for several years, but though it has been worked for a long period a comparatively small amount of the stone has been quarried.

§ 48. *Clarion Group, (Worth T.)*

There are few good exposures of the strata underlying the Ferriferous Limestone in this township. Fragmentary sections may be obtained at several places on Slippery Rock Creek, but complete exposures are rare. The following sections of this group, and of the upper part of the Conglomerate or Beaver River series, were made in August, 1875, from exposures on Slippery Rock Creek. Most of them are in Lawrence county, but are here given to show the character of these rocks, and to connect this report in a general way with Prof. J. P. Lesley's "Slippery Rock Report," published in volume "J," 1875.

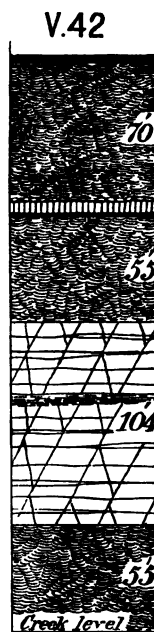
At Seceder's or Eckert's bridge, three miles west of Por-

tersville, Slippery Rock Creek flows at the bottom of a deep canyon like gorge, flanked on both sides by almost vertical escarpments of the Homewood and Connoquenessing sandstones. These two rocks apparently form a solid mass of sandstone, 104 feet thick, but Mr. White informs me that he has found a thin seam of slate or shale parting them near the middle.

The section shown in Fig. 42, was copied from exposures in this vicinity:

Section at Seceder Bridge.

Kittanning Middle Coal,	8'
Shale,	70'
Ore,	1'
Ferriferous Limestone,	6'
Coal, (Scrubgrass,)	—
Shale, partly concealed,	55'
Homewood SS.,	} 104'
Mercer shale, (thin,)	
Upper Connoquenessing, SS.,	
Shale to creek level,	55'



Neither the Brookville or Clarion coal beds were detected, but the Scrubgrass coal is represented by a very thin seam occurring immediately beneath the Ferriferous Limestone. The latter rock here carries a layer of ore about one foot thick, from which a small quantity has been stripped for use in the old furnace at Rose Point.

At Forest Mills the latter rock is well exposed at Kildoo's quarry, where it measures about 18 feet, and has been quarried and burnt for a long period. The Connoquenessing Sandstone is here almost entirely replaced by shale. The measurements shown in section 43 were made in this vicinity, and fail to show the presence of either the Brookville or Clarion Coal beds.

The lower part of the preceding section was obtained from exposures along the creek bank, about one mile north of Forest mills.

Section at Forest Mills.

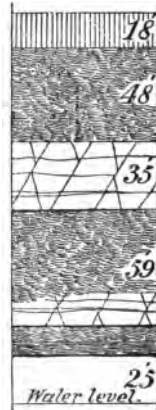
Ferriferous Limestone,	18'
Shale,	48'
Homewood Sandstone,	35'
Thin coal seam, (Mercer?)	—
Shale, with sandstone on base,	59'
Coal,	0' 4"
Olive shale,	8'
Blue shaly slate,	6'
Coal,	0' 9"
Shale to water level in dam,	25'

Going northward up the valley towards Rose Point, [Williereux P. O.,] the Homewood Sandstone gradually sinks lower and lower beneath the Ferriferous Limestone until there is an interval of 75 feet between them. The section shown in Fig. 44 was obtained at the latter place:

Rose Point Section.

Ore,	variable.
Ferriferous Limestone,	15' to 20'
Scrubgrass Coal,	6" to 1'
Blue slate and shale,	75'
Homewood S. S. conglomeratic,	20' to 25'
Blue slate,	0' to 2'
Coal, (Mercer Group,)	1' 6"

V.43



V.44

§ 49. *Mercer Coal Bed, (Worth T.)*

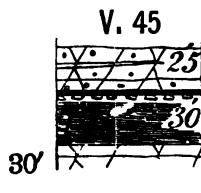
The coal shown at the bottom of the above section belongs to the Mercer Group of Interconglomerate coal beds. The limestone which usually accompanies these beds in Mercer and Lawrence counties is absent, but may be represented by a band of calcareous iron ore that underlies the coal. The blue slate that overlies the coal also contains some iron ore, in nodules, but it is not a persistent layer, and apparently exists only in "pots."

The following sections were made on the creek between Rose Point and the mouth of Wolf Creek, and will serve to illustrate the character of the measures lying between

the Ferriferous Limestone and creek level. They need no further discussion.

Section at Kennedy's Mills.—Fig. 45.

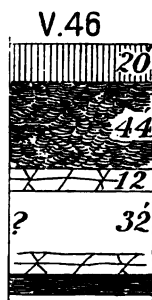
Homewood Sandstone, coarse and conglomeratic,	25'
(Coal Mercer,)	2'
Ore (Mercer Limestone,)	1'
Blue slate about,	25'
SS. thin bedded to water level,	5' }



Section at McCracken's Bridge.—

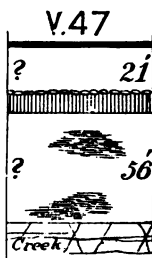
Fig. 46.

Ferriferous Limestone (about)	20'
Slate,	44'
Sandstone—in quarry,	12'
Concealed,	32'
Sandstone fine grained,	10'
Coal seam,	thin.
Slate to water level,	10'



Section at Elliott's Bridge [Red Bridge?]—Fig. 47.

Coal—Lower Kittanning, (?)	3'
Concealed,	21'
Ore,	2'
Ferriferous limestone,	10'
Slate—partly concealed,	56'
Homewood SS. to water level,	4'



The next section on Slippery Rock Creek was constructed from exposures near the mouth of Wolf Creek in Worth township. The Ferriferous limestone is laid bare by several quarries in that neighborhood, and is also seen at a number of outcrops along the roads leading to the bridges over Wolf and Slippery Rock Creeks. It here wears its usual character, but carries little or no iron ore. The measurements made in this locality are shown in Fig. 48.

The Scrubgrass coal bed has frequently been dug into in this vicinity, but was never found thicker than fifteen inches, and, though it is said to be an excellent coal, is of course too thin to mine.

Section at Mouth of Wolf Creek.

Shale.

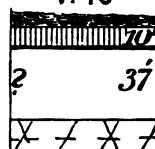
Ferroferous Limestone, 10'

Coal (reported 15'') 1'

Concealed, 37'

Homewood Sandstone, at bridge, . . . 10'

V.48

*§ 50. Brady Township.*

This township lies east of Worth and north of Franklin township. Through its southern part sweeps the Muddy Creek and Slippery Rock Divide, with summits ranging from 275 to 350 feet above stream level; but the northeastern portion of the township is gently undulating with summits seldom more than 125 feet above Slippery Rock creek.

Its high lands are capped by the Mahoning Sandstone, beneath which occurs the Freeport Group. The latter is poorly represented, and is almost worthless, though both its coals are found in some localities.

The Kittanning group outcrops on all the hillsides, and furnishes two good coals of workable size, viz.: the Upper and Middle Kittanning beds. The former has its area of best development in the northern and eastern parts of the township, but the last named coal is available, as a workable bed, only in the south-western portion.

In the country bordering Slippery Rock creek, the Ferroferous Limestone is constantly accessible, but has not been quarried much. This is probably partly owing to the difficulty of finding its outcrop in a favorable position, and in good condition for quarrying; the erosion being so smooth and the hill slopes so gradual, that a large amount of surface would generally have to be removed before solid limestone could be reached.

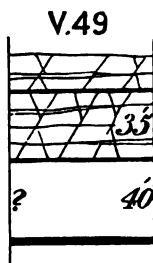
Along the low lands of the creek valley, the Homewood Sandstone is sometimes laid bare, and is occasionally suitable for building purposes.

In going south-east from West Liberty, on the road to Prospect, the first coal opening is on the Kittanning Middle

bed. The bank is now shut, and no measurement of the coal can be made; but I am informed that it is about three feet thick. A short distance beyond this entry, the section shown in Fig. 49 was compiled.

West Liberty Section.

Thin-bedded Sandstone, shaly, (Freeport,)		—
Coal, poor, (Currie Local Coal t)		1'
Thin bedded shaly sandstone, 10'	} Freeport, }	35'
Hard SS., some massive layers, 25'		
Kittanning Upper coal, blossom, . .		1'
Concealed,		40'
Kittanning Middle coal,		3'



The blossoms of both the Upper Kittanning and "Currie" (Local) coal beds are exposed on the road, but, from their size and character, indicate that these beds are rather thin, and too slaty to be valuable. The latter bed is enclosed in the Freeport Sandstone, which is quite a prominent sand-rock in this part of the township.

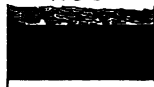
About one mile south-east from where the preceding exposures were observed, the Middle Kittanning coal is opened by Mr. J. P. Martin, at whose bank the bed measures: [See Fig. 50.]

Martin Coal Bank.

Shale roof.

Slaty coal, 7"	} 2' 9"
Coal, 2' 2"	

V.50



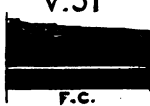
Though this bank has been worked at intervals for a long time, comparatively little coal has been extracted from it. A thin seam of slate occasionally traverses the coal near the middle of the bed. On the opposite side of the dividing ridge, and about one mile farther south, is the Lutz bank, at which the same bed is opened. It exhibits the structure shown in Fig. 51.

On the D. Graham farm, adjoining the place owned by Mr. Lutz, there is another bank in running order upon the

same bed, which there lies very nearly at water level. As these banks have been worked almost exclusively to supply the wants of the owners, and of parties living in their immediate vicinity, very little coal has been taken from them.

Lutz Coal Bank.

Slate roof.


Slaty coal,	0' 4"	} 3' 0"	
Coal,	1' 6"		
Sulphur band and bone,	0' 2"		
Coal,	1' 0"		

Fireclay floor.

This bed (Kittanning Middle) is being steadily worked at the bank owned by Mr. William Davis, in the southwestern corner of the township. It is rather too pyritous to be of good quality, but is very free from slate or bone, and measures: [See Fig. 52.]

Davis Coal Bank.

Shale roof.

Slaty coal,	3"	} 2' 10"	
Coal,	2' 7"		

Mr. Bryan has also opened a bank on this bed, a short distance from the Davis bank, in which the coal is of similar character and thickness. In his bank the upper bench of slaty coal thickens from three to six inches, and can be left in the bank as a roof. The coal is said to be three feet thick at the old saw mill on Muddy creek, near Mr. Weitzel's house. The bed there lies nearly at creek level, and was opened and worked quite largely many years ago, but the bank has long been closed, and no examination of the bed was possible.

The Kittanning Middle coal is also opened and mined in the western part of the township, one mile south from West Liberty, by two banks on the adjoining farms owned by Messrs. J. and T. Badger. At the opening owned by Mr. J. Badger, on the west side of the hollow, it measures about three feet and two inches, with a two inch seam of draw-slate on top. About one foot of the uppermost part is rather slaty, but the remainder of the bed is good coal.

A thin parting of slate is occasionally seen about ten inches above the fire-clay, but it is not a persistent band.

In the hill above these banks, an entry has been driven in on a very impure bed of cannel coal, from five to seven feet thick, full of shaly slate, and alternating laminae of slate and cannel coal. In fact the bed may be described as a worthless mixture of shaly slate, slate, and slaty cannel coal, and is one of those local deposits that may occur at any horizon in the coal measures.

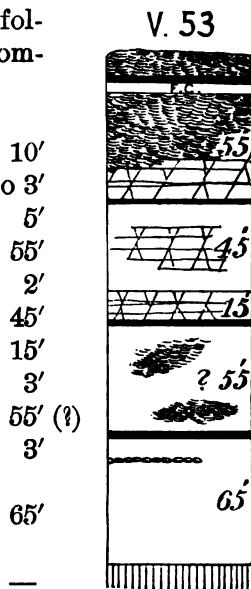
§ 51. Kittanning Upper Coal, (Brady T.)

In the neighborhood of Stone House, on the old Pittsburgh pike, in the north-eastern part of the township, this is quite a valuable seam, and has been opened and worked at a large number of banks, many of which are still in running order. The Middle Kittanning coal outcrops on the road about fifty feet beneath it, and is apparently three feet thick, but has not yet been opened in this locality.

In going southward along the Pike from Stone House to the summit, a distance of one mile, the following section—shown in Fig. 53—was compiled from exposures in the road bed.

Stone House Section.

Shale on summit	10'
Freeport Upper Coal—blossom, . .	2' to 3'
Fireclay,	5'
Shale,—Sandstone near bottom, . .	55'
Freeport Lower Coal—blossom, . .	2'
Concealed—with massive SS. . .	45'
Sandstone,—hard and massive, . .	15'
Kittanning Upper Coal,	3'
Concealed—mostly shale, . . .	55' (?)
Kittanning Middle Coal,	3'
Concealed,	10' }
Ore band,	— }
Concealed,	55' }
Ferriferous Limestone,	—



The Freeport Upper and Lower Coal beds, separated by

about sixty feet of shaly measures, outcrop near the summit, but are hardly of workable size. No trace was seen of either of their accompanying beds of limestone. About sixty feet beneath the Lower Freeport Coal, there are two old openings on the Kittanning Upper Coal Bed. These have long since fallen shut, and nothing can now be seen except some old coal on the dump heaps. A hard massive sandrock—Freeport sandstone—fifteen feet thick rests directly on the coal, forming its roof in these banks.

In the hollow at the foot of the hill, several imperfect outcrops of the Ferriferous Limestone are visible. It lies about 120 or 125 feet below the Kittanning Upper coal bed, and from 65 to 75 feet below the horizon of the Middle Kittanning coal, which outcrops near the cross roads at Stone House.

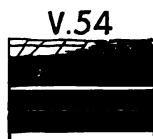
The principal banks now in running order, on the Upper Kittanning Bed near Stone House, are situated on the farms owned by Mr. Daniel Graham, Mr. Wigton, and Mr. Turk. The quality and thickness of the coal are about the same in all of these banks, and one measurement will serve to show its structure in this vicinity.

At the opening owned by Mr. Daniel Graham, a measurement gave the thickness shown in Fig. 54:

Graham Coal Bank.

Slate and sandstone roof.

Slaty roof, (draw slate?)	7"	} 3' 9"
Coal,	11"	
Slaty coal,	2"	
Coal,	1' 0"	
Soft parting,	thin.	
Coal,	1' 1"	}



The coal is of good quality, with only a moderate amount of pyrites, and mines in large pieces.

It has also been opened at two banks by Mr. Josiah Graham, one mile west from Stone House. One of these has fallen into disuse, and within a few rods of its mouth Mrs. Mary Weber has had a bank opened. In all of these openings the coal shows about the same structure.

It is of very fair quality and measures—[see Fig. 55:]

Weber Coal Bank.

Shale roof.

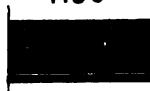
Slaty coal,	5"	} 3' 2"	
Coal,	6"		
Slaty coal,	2"		
Coal,	2' 1"		

At the cross roads one mile southwest from Stone House, the smuts of both the Upper and Middle Kittanning Coal beds were seen in the road gutters. They here lie about forty feet apart.

In this vicinity Mr. Hugh Grossman has a bank opened on a coal about three feet thick, which is probably the Upper Kittanning bed.

About one mile northwest from the Badger Banks, and close to the Worth township line, two banks are opened near Mr. Robert Glenn's house. One of them is now fallen shut, but the other—a new opening—is very substantially built and is in good running order. It lies 35 feet higher than the Badger Banks, and is probably on the same (Middle Kittanning) bed, but, in the absence of any good key rock, its identification with this bed is quite uncertain. Near the mouth of the entry a measurement gave the thickness shown by Fig. 56:

Glenn's Coal Bank.

Very slaty coal—draw slate, . . .	5"	} 3' 1"	
Coal, slaty,	1' 0"		
Coal, good,	1' 3"		
Slate,	1"		
Coal,	4"		

The following record of the John Smith Well, (See Plate VI,) was kindly furnished by Messrs. Phillips Bros., and is said to be a correct description of the strata drilled through. It exhibits features precisely similar to the Bullion, Reno, and Oil Creek well records. The Big Red Rock over the first sand is especially noticeable, and is a most important key stratum, as it is found at a nearly constant horizon over a large area from Franklin southwestward to this vicinity and westward to the Ohio line.

John Smith Well, (drilled in 1877.)

On J. Smith farm, Brady township, one and a quarter miles northwest from the Prospect bridge over Muddy Creek. Authority E. I. Agnew, per W. G. Power.

Slate and fire-clay,	230	to	230
Limestone; FERRIFEROUS,	15	to	245
Slate and clay,	27	to	272
Sand-rock,	18	to	290
Block slate,	110	to	400
Sand-rock,	65	to	465
Slate,	3	to	468
Mountain sand,	100	to	568
Slate and shells,	72	to	640
Grey sand,	50	to	690
Slate and shells,	10	to	700
Sand-rock,	30	to	730
Slate,	180	to	910
Sand-rock,	26	to	936
Slate and shells,	119	to	1055
RED ROCK,	60	to	1115
Slate and shells,	15	to	1130
First sand,	60	to	1190
Slate,	85	to	1275
Second sand,	} Second sand, {	20	to 1295
Slate,		20	to 1315
Sand-rock,		25	to 1340
Slate, (Note 1,)		55	to 1395
Granite, (Note 2,)		5	to 1400
Slate,		31	to 1431
Third sand, (off color,)		19	to 1450
Black slate, (pocket,)		8½	to 1458½

"Note 1. 55'. This should be the "Granite," which is a dark, sandy slate.

Note 2. 5'. This should be the "Stray" sand—it *underlies* the granite."

The Third sand was poor and quite shelly, and yielded no oil.

N. B. The above record is given as received in the driller's nomenclature. A shell is ~~any~~ hard stratum, usually sandy, but generally quite fine grained.

§ 52. *Clay Township.*

This township lies in the middle tier immediately north of Centre township.

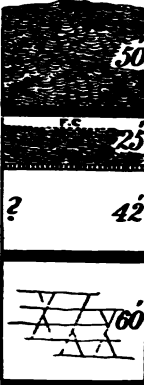
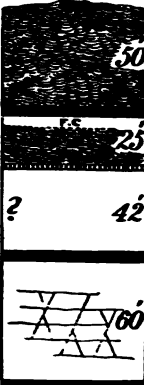
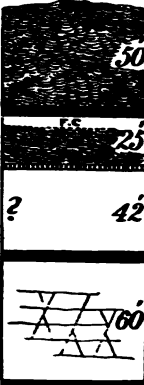
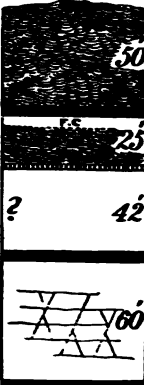
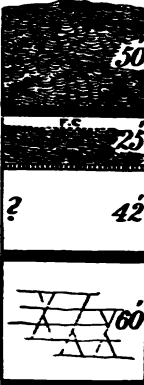
It is occupied by very hilly country with summits from 200 to 250 feet above water level. The divide between the Slippery Rock and Muddy Creek enters its western line near the centre, sweeps in a very irregular curve through the township, passing very close to Sunbury, and runs out of it in a southeasterly direction towards Middletown.

The Mahoning Sandstone and Freeport Group are caught in its high lands. Both the Upper and Lower Freeport coals are locally workable beds, and the Upper Freeport Limestone is sometimes present.

The Kittanning group occupies the low lands of the township, and is only available above water level over a small area.

The section shown in Fig. 57 was compiled from exposures in and around the borough of Sunbury. It can be regarded as a typical section of the measures in this township.

Sunbury Section.

Slaty and sandy shale on summits,	40'	50'	
Slaty shale,	10'		
Freeport Upper coal,	4'	25'	
Fireclay,			
Concealed, (with ore balls, shale, ?)		42'	
Freeport Upper Limestone,	3'		
Concealed,		50' to 60'	
Freeport Lower coal,	5'		
Fireclay,		2'	
Concealed, with hard, massive (Freeport) Sandstone.			
Kittanning Upper coal (?)	2'		

The Freeport Upper coal is opened and mined at the Thompson bank in Sunbury, where it is of quite good quality and mines in good sized pieces, but is somewhat troubled with pyrites binders. It shows no persistent slaty partings and measures: [Fig. 58.]

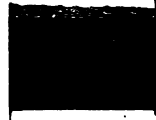
V.58

Thompson Coal Bank.

Shale roof—good.

Coal, 3' 3"

Coal, slaty and laminated, 1' 4"



At the bank owned by Mr. McMichael one mile southwest of town the bed measures three feet and eight inches and is divided into three benches. Most of the coal is mined from the middle or "two foot" bench which is rather sulphury, but resists weathering much better than would be expected. A large quantity is yearly taken from this opening for use in Sunbury and the adjacent country.

The bank is in excellent condition, and has a good roof of sandy slate that requires little timbering. A measurement of the bed made near the mouth of the entry, gave the structure shown in Fig. 59 :

McMichael Coal Bank.

Sandy slate roof—good.

Slaty coal, 8"

Coal, 2' 2"

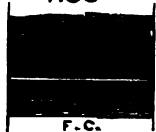
Slate, $\frac{1}{2}$ " to 1"

Coal, 10"

Slate, 1' 0"

Fireclay.

V.59




On the adjoining farm Mr. Painter has opened two banks on this bed ; and on the Patterson Farm, south of Sunbury, there is another entry in running order upon the same seam.

In no other part of the township is this bed, (Freeport Upper,) either of workable quality or thickness. In Washington township, northeast from Sunbury, it is often absent ; north from town it is thin ; west of this locality it can seldom be found, and is never a workable bed ; and south and southwest from this immediate vicinity it is always either too poor or too thin to mine ; but east and southeast of Clay township, and between it and the Brady's Bend country, in Armstrong county, this coal is often a locally workable bed, but is seldom either so good or so thick, and is never so valuable as it is at the Sunbury banks.

The Freeport Upper Limestone outcrops at several places near town, and at the race course, one half mile east of the

borough line. Attempts have frequently been made to burn it, but they resulted in the production of an inferior lime that no one would buy. The bed is from two and a half to three feet thick, and is associated with more or less nodular iron ore. It here lies about twenty-five feet below the Upper Freeport Coal bed, but as its presence was not detected in any other part of the township, it may be found in a somewhat different position in other localities.

The Freeport Lower Coal bed has been opened at several banks near Sunbury. At the opening owned by Mr. Wm. C. Glenn, the bed measures a total thickness of five feet, and would be a valuable seam were it not for the thick slate band that parts it into two benches. Figure 60 approximately shows its structure :

<i>Glenn Coal Bank, (Sunbury.)</i>		V.60
Coal,	2'	
Slate,	1'	
Coal,	2'	

Owing to some unaccountable oversight, this bank was not visited, and the above measurement is from a statement given me by a miner who had worked in the bank, and who professed to be familiar with all the coal banks near Sunbury.

On the Butler pike, one and a half miles south of Sunbury, the blossom of this bed can be seen in several places. It lies about seventy feet below the Upper Freeport Coal, and is sometimes overlaid by a rather coarse and massive (Upper Freeport) sandstone.

The Kittanning Upper Coal (?) has been opened and mined on the farm now owned by Mr. Samuel McElvain, near Sunbury, but the bank has been shut for over twenty years. It is said to measure two feet, and tradition says that it was a remarkable good coal, but was abandoned on account of being rather thin. This bed is probably the same with the coal mined by Mr. Glenn, in the southwestern corner of Washington township. At the latter locality a coal nearly four feet thick was found in a water well at about thirty feet below the Glenn Bank. This bed may be the

Upper Kittanning coal, and if such be the case, then the latter bank is opened on a stray bed lying near the horizon of the Currie Local Coal, and the McElvain coal must be referred to the same place in the measures. Its distance below the Upper Freeport Limestone is confirmatory of the correctness of this identification.

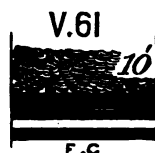
The Freeport Upper and Lower Coals are both well exposed in the southeastern part of the township.

A bank newly opened by Mr. Saml. Mock on the former bed gave a measurement of: (Fig. 61.)

Mock Coal Bank.

Shale roof (seen)	10' 0 "
Coal and Slate,	9 "
Slate,	$\frac{1}{2}$ " to 1 "
Coal,	5 $\frac{1}{2}$ "
Slate,	6 "
Coal,	6 "

Fireclay.



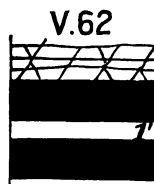
It is a very poor slaty bed and is of no value. The entry was pushed into the hill in expectation that the bed would lose its slate and improve in quality. It is needless to say that all such ideas are only delusive and can never be of any service to those depending upon them. A coal bed thickens or thins, improves or deteriorates, with no regard to the accidental shapes of hills or valleys produced by aerial erosion. It may be thickest at its outcrop, or under the highest part of the hill; or when it has least cover, and vice versa. On the farms owned by Mr. James Young and Mr. Robt. Patterson, three quarters of a mile north from Mock's Bank, there are two old banks on the Lower Freeport bed. The former bank has been shut for about twenty-five years, and no coal has been taken from the Patterson opening for over fourteen years.

Mr. Young states that as nearly as he can recollect the bed measured (Fig. 62—compare Fig. 60.)

Young Coal Bank.

Coal,	2'
Slate,	1'
Coal,	2'

6 V.



It is immediately overlain by the Upper Freeport Sandstone which is a hard massive rock, more than ten feet thick.

A short distance southwest from the Mock bank, and near the junction of this road with the Butler pike, Mr. McAnallen has an old bank on the Lower Freeport bed, which here lies about seventy feet beneath the Upper Freeport Coal. This opening has been closed for a number of years, and no examination of the bed could be made, but the coal is said to be rather slaty, and was not very highly prized by any who had used it.

Near the Baptist Sunday School building, in the southern part of the township, two banks have been opened in close proximity to each other, on a bed lying near the horizon of the Lower Freeport bed, but which may possibly be the Upper Kittanning Coal bed.

The coal is of fair quality, but the bed is rather variable in thickness. A measurement made in the bank on the main road gave [See Fig. 63.]

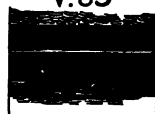
School House Coal Bank.

Shale roof.

Coal,	1' 4"
Slate,	1"
Coal,	1' 7"
Slate and coal,	9"

Shaly slate floor.

V.63



The coal here exhibits a violent dip towards the south, but this is probably local.

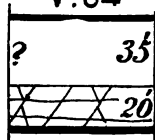
The same bed has been opened about one and a half miles west from these banks, but was abandoned several years ago and the entry is now closed. It is said to be about three feet thick.

The exposures seen in this neighborhood give the section shown in Fig. 64, as follows:

School House Section.

Coal (Upper? Freeport Lower?)	2'
Partly concealed,	35'
Hard massive sandstone,	20'
Coal (Freeport Lower? Kitt. Upper?) .	3'

V.64



If the coal opened be the Kittanning Upper bed, the bed

seen in blossom fifty-five feet above it is the Freeport Lower Coal, but if the former be the Lower Freeport then the latter must be the Freeport Upper bed. In either case the interval between them seems to be too small, but this may be partly owing to an error in the measurements occasioned by the sharp south dip which seems to pervade the measures in this locality.

In the northeastern corner of the township, the Upper Kittanning coal is opened and mined on the land owned by Mr. Hall. The coal here shows about the same character and thickness that it exhibits in the Stone House Banks in Franklin township, measuring about three feet of good coal, with a roof of sandy shale and a fireclay floor.

§ 53. *Concord Township.*

This township lies east of Clay and north of Oakland townships, and is rather poorly supplied with coal, but the existence of oil territory within its limits has amply compensated it for this deficiency.

The great Allegheny and Beaver River Divide sweeps through it in nearly a north and south line, passing close to the old borough of Middletown. This town is situated at the juncture of the Slippery Rock and Muddy Creek divide with the Muddy Creek and Connoquenessing dividing ridge and the first named water shed. It can therefore be considered as the centre of the drainage system of northern Butler. Muddy Creek, the main Branch of Bear Creek, the South Branch of Slippery Rock Creek, Buffalo Creek, and Kearn's Branch of the Connoquenessing, all rise in its vicinity.

The surface of this township is made entirely from the outcrops of the Freeport Group, the Mahoning Sandstone, and a small part of the lower portion of the Barren Measures. The latter is only found in the high lands near the Oakland township line, east and west from Greece City.

The Freeport Upper Coal (Millerstown bed?) has been opened by Mr. J. Ray on his farm about a mile and a half

west of Middletown, but the mouth of the entry is closed at present.

About 110 feet below it, a bed has been opened on the place owned by Mr. J. Young, which resembles somewhat the Upper Kittanning coal. If the Ray Bank be on the Millerstown bed, then this coal is the Lower Freeport bed. I am inclined to think the latter identification correct.

Mr. Young drove this entry in a short distance, and then abandoned it, on account of the unsatisfactory quality of the coal. There is now visible at the opening, (see Fig. 65.)

J. Young's coal bank.

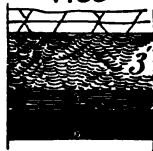
Massive yellowish sandstone.

Shale roof, 3'

Black shaly "draw slate," 1'

Coal, (seen,) 1' 6"

V.65



Near the Presbyterian church at Middletown, there is an old bank, on one of the Freeport beds, from which a large quantity of coal has been taken. The mouth of the entry has fallen shut, and no examination of the bed could be made. About forty-five feet above it, the blossom of another bed (Millerstown Coal bed ?) is seen in the road, but from the character of the outcrop I should not think that the bed contained more than two feet of coal.

The Mahoning Sandstone is seldom a prominent stratum in this township, being generally largely replaced by sandy shale. The Freeport Lower Sandstone is also quite a shaly rock, and so far loses its peculiar lithological characteristics that it cannot be depended upon as a key rock in identifying its underlying or overlying coal beds.

The Upper Freeport Coal bed has been opened by Mr. Rider, on the road running northwest from Boydstown, and about one mile west of Greece City, but this bank has already been mentioned in the description of Oakland township, and nothing further need be said of it in this connection.

On the Jamison farm near Greece City, the Millerstown (?) Coal bed (Upper Freeport bed ?) is mined quite largely for use at the oil wells. The coal is rather slaty, but mines

easily and commands a ready sale. A measurement made at this bank gave the structure shown in Fig. 66.

Jamieson coal bank.

Shale roof.

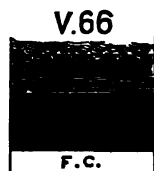
Black slate, 4"

Slate and coal, 8"

Coal, with slaty laminæ, 1' 0"

Coal, good, 1' 10"

Fireclay floor.



About forty-five feet below this bed, the blossom of the Freeport Upper [Lower?] coal is seen at several places along the road side. It is not a workable bed.

The Freeport Upper Limestone was not detected in this locality, though much time was spent in searching for some trace of it.

On the high ridge north from Middletown, the outcrop of Freeport Upper Limestone is exposed in several places. The fragments seen on the North Washington road, indicate that there are two beds present, lying fifty or sixty feet apart, but it is possible that the fragments seen at the lower level, have come from the upper bed. The latter is from two to four feet thick. A few feet above it, the smut of the Upper Freeport Coal is seen, but the character of its blossom indicates that it is quite thin.

Though the Freeport Lower bed can frequently be detected in the exposures along the roads, in the northern part of the township, it is not opened north of Middletown, and is probably either too thin or too poor, to be of any value.

§ 54. "*Fourth Sand*" Oil Territory.

The first successful well drilled in the Butler County Oil District was located in this township. It was situated at Modoc City on the Troutman Farm, and was struck March 23d, 1873.

The "*Fourth Sand*" productive territory, as at present developed, sweeps across the township in a comparatively narrow belt from the central part of the Fairview township line to its terminus at Greece City near the middle of the

north line of Oakland township. West and southwest from Greece City, the country has been riddled with holes in search of a prolongation of this belt, but up to the present time no producing wells have been found outside the "belt" limits. Many of these wells are reported as having found a sand of good quality and of unlooked for thickness, but containing no oil.

All the oil produced in this township is from the Fourth Sand which here lies from thirty to fifty feet beneath the Third Oil Sand.

§ 55. *Fairview Township.*

This township lies east of Concord and north of Donegal township, and adjoins Armstrong county along its eastern line.

In it the rocks included between the Mahoning Sandstone and the Upper Kittanning coal bed are all well exposed, but fail to show the presence of any good coal beds. Both the Upper and Lower Freeport coal beds are quite poor and thin, and though many attempts have been made to work them, their worthlessness always stopped operations. Nearly all the coal now mined in the township is taken from the Millerstown coal bed, and the Upper Kittanning (Central Point) bed.

But few good farms are noticed in this township. This is partially owing to the existence of oil over so large a portion of its area, and partially to the fact that much of the land is "worked out," and sadly needs an inorganic fertilizer, such as lime, the phosphate fertilizers, etc.

When oil is struck in a well, the farm on which it is situated, no matter how good an one it may be, usually falls into a totally neglected state, and fast goes back to its primitive condition. The fences are torn down, weeds are allowed an unobstructed growth, oil filters through the soil in all directions, a young growth of brush springs up, and in a few years all signs of a good farm have been obliterated. Such is the condition of much of the arable land in Fairview township.

The "Third Sand Oil Belt" which runs across the township in a direction of about N. 22° E., S. 22° W., consists of several sub-belts, to which the following different names have been given, "Eastern Belt" (in two sub-divisions), "Sucker Rod Belt" and "Western Belt." These are supposed to be narrow, continuous "streaks" of porous, more or less pebbly sandstone, separated from each other by hard, close sandrock incapable of holding or yielding oil in paying quantities.*

The "Fourth Sand Oil Belt" crosses from west to east in a curved line, bearing N. 45° E. to N. 80° E. At the western edge of the township it is rather narrow, but broadens out on approaching Karns City and Petrolia, only to narrow down again before passing eastward into Armstrong county.

The sand in which the wells on this belt find their oil lies from forty to seventy feet beneath the Third Sand. The Millerstown Eastern Belt also finds its oil at this horizon.

In the neighborhood of Karns City, Petrolia and Fairview, oil has been found in both the Third and Fourth Sands. The first wells put down in this vicinity were drilled only to the Third Sand and were considered good wells. The existence of a Fourth Sand was not then known, but when it became evident that the Modoc sand was a lower stratum

* It must not be supposed that because a sandrock is close and finegrained, is incapable of holding oil in quantity. On the contrary, we know that if the grains of sand were spherical, a finegrained rock would be capable of holding as much oil as a coarser grained, or pebbly sandstone, for the "intermolecular" spaces would bear the same ratio to the solid contents in one case as in the other, assuming that there were no cementing material in either rock.

In many places where the oil sand is very finegrained, it is found to be thoroughly saturated with oil, and often probably holds at least half as much oil as the coarser portions of the Third Sand.

But the objection to this view is that a fine grained sand—though soaked with oil—always is but sparingly productive, yielding very small wells and dry holes. That such is the experience of operators is not surprising, indeed it could not be otherwise, for the oil in any well, only flows from the rock into the well by reason of pressure from the imprisoned gas, and in a fine grained rock this is *counterbalanced by molecular attraction*, holding the oil in the rock, or allowing it to percolate into the well very slowly.

Not only are the finegrained sandrocks often saturated with oil, but the shales overlying and underlying the oil sand, are sometimes soaked with it; this is not the rule, but an exception to it.

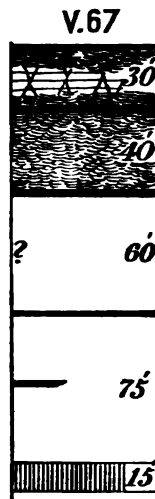
H. M. C.

than the sand at Petrolia, many operators again started the drill in their then declining wells, and were rewarded by very large flowing wells, some of which are said to have produced over 3000 barrels in twenty-four hours.

The section shown by Fig. 67 was compiled from exposures observed in the valley of Big Bear Creek about one and a half miles northwest from Fairview.

Big Bear Creek section.

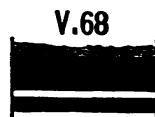
Freeport Lower Coal,	blossom.	
Concealed—SS. and shale, . .	30'	
Coal—Currie Local bed (?) . . .	3'	?
Concealed,—sandy shale, . . .	40'	60'
Kittanning Upper Coal,	3'	
Concealed (about)	60'	
Kittanning Middle Coal,	2'	75'
Concealed,—contains Lower Kittanning Coal bed,	75'	
Ferriferous Limestone,	15'	15'



In the above section a three foot bed of coal is noted at the horizon of the Currie Local coal lying in the interval usually occupied by the Freeport Sandstone. This bed is opened at several banks and yields a good hard coal, mining in large pieces, but is somewhat troubled with sulphur binders. At the opening owned and worked by Mr. Lucas a measurement gave see (Fig. 68.)

Lucas coal bank.

Shale roof.	
Coal,	1' 6" to 1' 9"
Slate,	5"
Coal, about	7"



Forty feet below this bank lies the bed on which Mr. Watson is working a bank. This is the Kittanning Upper bed, and is of quite good quality, being free from pyrites, and mining very nicely. All the slate is left in the bank as a roof. Near the mouth of the entry the coal shows this structure (see Fig. 69.)

The Kittanning Middle Coal bed and the Ferriferous

Limestone have been transferred to the preceding section (Fig. 67) from exposures near the mouth of Silver Creek in Parker township, and will be discussed in the description of that township. The Lower Kittanning coal which is seen at stream level near Argyle will also be described in connection with Parker township.

Watson coal bank.

Shale roof.

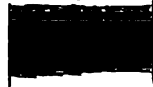
Slaty coal—left for roof, 4"

Soft parting, $\frac{1}{2}$ "

Coal, 2' 2"

Slate floor.

V.69



In the vicinity of Central Point, one half mile south of Petrolia, the Kittanning Upper bed has been opened and mined at a number of banks, from which a large amount of coal has been taken. The bed here shows an unusual thickness, but explorations made in the country north and northwest from Central Point, show that it is only a very local enlargement. Going southward it soon passes beneath water level in Little Bear Creek.

This coal was not noted by Mr. J. H. Carll in his record of the Hazelwood Well No. 21, (see Chapter X,) which is located on the hill north of these banks, but I have inserted it in the record to show its place with reference to the Ferriferous Limestone at Central Point. It usually shows about the following thickness:

Central Point coal bank.

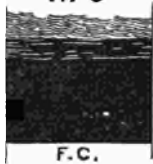
Grey shale roof.

Cannel slate, 11"

Coal, 4' 3"

Fireclay floor.

V.70



The Currie Local coal is represented at Petrolia by a thin vein of cannel coal nine inches thick, resting on a bed of fireclay, and lying about thirty feet above the Sheakley (Upper Kittanning) Coal Banks. It has been opened in several places near town, but is always too thin to mine.

The Freeport Lower Sandstone has here—as in nearly every other part of the township—a very shaly character, and it is extremely difficult to determine its horizon or

place of outcrop, by means of topographical features. We have, in fact, no key rock to guide us in the identification of the coals of this township, except the Ferriferous Limestone, and as this stratum is always beneath water level, we are forced to make use of oil well records to obtain its distance below the various coal beds of the series.

The Freeport Lower Coal is occasionally seen in blossom on the roadsides, but it is never of good quality or workable size. Its underlying limestone is seldom seen on the surface, but it is reported as having been passed through by many oil wells. The records kept by Mr. Carll, and published in Chapter X of this report, show the presence of this stratum, but it was so thin that on measurement was made of it.

The smut of the Freeport Upper coal was occasionally observed, but the bed is quite thin, and always very poor and slaty, and unfit for mining. A few feet below it, fragments of the Upper Freeport limestone are sometimes found, but the bed was never seen in situ, and its thickness cannot be stated.

§ 56. *Millerstown Coal. (Fairview T.)*

This bed is mined quite extensively at Karns City; from Karns City to Angelica; from Angelica and Buena Vista to Millerstown; and between Karns City and Millerstown.

The Ferriferous Limestone, as determined by several oil well records, underlies it by from 295 to 315 feet. It, therefore, as already stated in chapter IV, lies in the horizon of the Mahoning sandstone, but this rock is never a hard or massive sandstone within the limits of good development of this coal bed.

The coal is of rather inferior quality, and were there not a great demand for coal at the oil wells, very little of it would be mined.

At the bank owned by Mrs. Martha Storey, one mile south of Fairview, the coal exhibits the structure shown in Fig. 71. Going down the stream from this bank, the coal is opened at intervals all the way to Karns City.

Mrs. Storey's Coal Bank.

Sandstone: (reported) upper part of the Mahoning SS.

Slate roof,	10'
Poor slaty coal,	1' 7"
Coal,	2' 1"
Fireclay floor.	

The upper bench is always a poor slaty coal, and is generally left in the mine as a roof. At Karns City this bench swells to over two feet, and is quite variable both in thickness and character. At the opening worked by the Karns City and Butler Railroad Company, the bed over four feet thick as shown in Fig. 72, and has a slate floor.

Railroad Coal Bank.

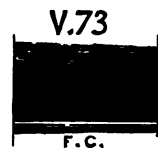
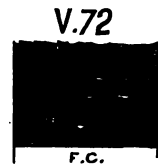
Shale roof.	
Black slate, (draw slate),	6"
Slate and coal,	1' 0"
Poor slaty coal,	11" to 1' 0"
Coal,	2' 0" to 2' 3"
Slate,	2"
Fireclay floor.	

In the hollow southeast from town, at the Gardner bank on the Kincaid farm, a thin seam of coal comes in beneath the lower band of slate. A measurement made at this opening, gave: (Fig. 73.)

Gardner Coal Bank.

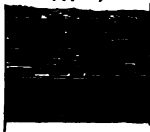
Dark slate roof.	
Slaty coal,	1' 0"
Coal,	2' 6"
Slate,	2"
Coal,	3"
Fireclay floor.	

On Buffalo creek, between Buena Vista and Millerstown, the bed is mined quite extensively. The upper bench is nearly worthless, but the lower bench yields a very fair coal. The following measurement, illustrated by Fig. 74, made in a bank on the Barnhart farm, will show the structure of the bed in this locality:



Barnhart Coal Bank.

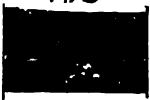
Shale roof.

Slate, dark,	9"	V.74
Slate and coal,	1' 3"	
Slaty coal,	1' 0"	
Soft parting,	$\frac{1}{2}$ " to 1"	
Coal,	2' 3"	

At the bank, opened near Mr. Nolan's house, one half mile north from Millerstown, the coal is of very poor quality, containing throughout the bed many small seams of slate. The bed was measured with the following result: (Fig. 75.)

Nolan Coal Bank.

Shaly slate roof.

Coal,	4" to 6"	V.75
Slate,	8"	
Slaty coal,	1' 0"	
Coal, (seen,)	1' 6"	

The above description is intended only to apply to the bank situated on the southeast side of the road running eastward across Smith's Run.

CHAPTER VIII.

§57. *The Third Tier of Townships.*

This row of townships, including Slippery Rock, Cherry, Washington, and Parker lies north of the tier described in Chapter VII, and forms a row extending across the county from west to east. This row, and the range north of it, consist only of four townships each, the place of the fifth being cut off by a truncation of the northwestern corner of the county by the Lawrence and Mercer county lines.

The highest land is in Washington township, on the great dividing ridge, going west of which the summits gradually become lower and lower until at Centerville the highest ridges are more than a hundred feet lower than those near North Washington. Eastward the descent into Bear Creek Valley is quite abrupt.

The Freeport Upper Coal and Limestone are caught in the high lands of Parker and Washington townships, but in Cherry and Slippery Rock township, the top rock is usually the Freeport Lower Sandstone. In the former locality the Freeport Lower Coal bed is locally a very thick seam, and has been mined quite largely, but it is to the Kittanning coal beds that we must look for a future supply of fuel for these townships.

The Clarion Group lies near water level on most of the tributaries to Bear Creek and the Slippery Rock, but is not of much value, though in some places a large quantity of coal has been mined from its lower bed. On Wolf Creek, and also on Bear Creek, the horizon of the Brookville Coal is occupied by the Homewood Sandstone, but in the country lying between these streams the sandrock sinks, and the coal is found in its normal position and of workable thickness.

The Ferriferous Limestone is exposed and quarried at

several places in these townships, being used both for building and agricultural purposes. It seldom carries ore thick enough to be profitably mined or stripped.

§58. *Slippery Rock Township.*

This township lies in the forks of Wolf and Slippery Rock Creeks, and has, consequently, suffered severely from erosion. Its highest hills seldom exceed an elevation of 1300 feet, and the average height of this area is not more than 1150 feet above ocean level.

It is bounded on the south by both Brady and Worth townships, and adjoins Mercer and Lawrence counties on the northeast.

The soil of about nine tenths of its area is formed from the outcrop of the Lower Productive Coal measures, and the remaining tenth consists of the bottom lands found on Slippery Rock and Wolf Creeks and their branches. These streams generally cut down to the top of the Homewood Sandstone, but where the former is crossed by the Harrisville anticlinal, the horizon of the Mercer Group is brought above water level.

Much excellent farming land is found on both sides of Slippery Rock Creek. The best soil occurs at from thirty to one hundred feet above water level, and is resultant from the presence of the Ferriferous Limestone. Though this rock is not thick enough to form a typical limestone soil, its presence greatly improves the land.

The Freeport Lower sandstone is caught in the highest hilltops, but does not make any marked topographical features, being usually a soft shaly rock, yielding to erosion as readily as shale or slate.

Both the Kittanning Middle and Upper coal beds have been opened and worked for many years, but neither of them are as good in quality as they are in Worth and Brady townships.

The best development of the Middle Kittanning is found in the northeastern part of the township, and is a continuation southward of the Harrisville Coal Field.

On the farm owned by Mr. Harvey Hogg, a bed of coal

measuring about three feet with one thin parting of slate near the middle was opened and worked several years ago, but the bank has long been closed. The same bed is opened by Mr. Bingham, Mr. George Christley, and Mrs. Margaret Allen. It is probably the same with Harrisville bed.

It has also been opened and mined quite largely from several banks situated one and a half miles due north from Centerville. These banks are located on the *north* side of the Harrisville anticlinal axis, and exhibit quite a sharp north dip. Between the Weakley Banks on the southeast and the Hayes and Gill Banks on the northwest there is a north dip of at least forty feet. These openings are but one half mile apart. The subjoined measurements and the character of the coal prove that they are all situated on the same bed. (See Fig. 76.)

R. H. Weakley Bank.

.....		
Slaty coal, (draw slate,)	7"	5"
Coal,	11"	1' 2"
Slate,	2"	2"
Coal,	1' 11"	2' 0"
Total,	3' 7"	3' 9"

Fireclay floor.

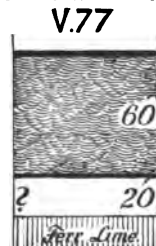
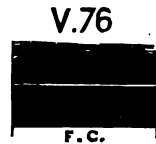
Fireclay floor.

The coal is of fair quality, and mines in good large pieces from those parts of the bed that have sufficient cover. The Hayes and Gill banks are probably very near the centre of the Harrisville synclinal trough.

The section shown in Fig. 77, compiled from exposures observed on the road to New Hope Woolen Mills, shows the relation of the Kittanning Lower coals to the Ferriferous Limestone. The latter rock was not well exposed on the east side of Wolf creek, and its thickness could not be measured.

Section at New Hope Woolen Mills.

Kittanning Middle coal,	3'
Concealed, shale,	60'
Kittanning Lower (Ferriferous?) coal,	2'
Concealed,	20'
Ferriferous Limestone,	—

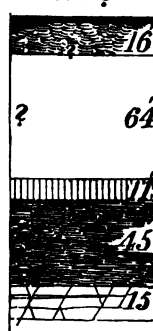


On the west side of Wolf Creek the section shown in Fig. 78 was measured. It is very similar to the preceding one, but shows the presence of an additional coal coming in beneath the Kittanning Middle Bed. This bed was only seen at one place on the road, where its blossom was rather thin and indistinct, and it may possibly be a slip from the latter coal bed. It appeared, however to be *in situ*, and may be a very local stratum.

McKee section.

Kittanning Middle coal,	3'
Concealed—shale,	18'
Coal blossom,	?
Concealed,	64'
Ferriferous Limestone,	11'
Blue slate,	45'
Homewood SS., to creek level, . 10'	} 15'
Homewood SS., beneath water	
level (seen, . . . 5')	

V. 78



The Kittanning Middle bed has been opened and mined by Hon. David McKee, where the coal measures about three feet. At the time this bank was visited its mouth was closed and no examination of the bed could be made.

A short distance north from Mr. McKee's residence, the Ferriferous Limestone is quarried and burnt. Nearly ten feet of the stone is exposed, and from the character of outcrop it is safe to say that the bed is three or four feet thicker. The quarry is an old one and yields very good lime, but the kiln is new, having been built quite recently.

Neither the Scrubgrass nor the Clarion coal bed are exposed in this vicinity, and the Brookville bed is cut out by the Homewood Sandstone, the top of which lies only forty or forty-five feet beneath the limestone.

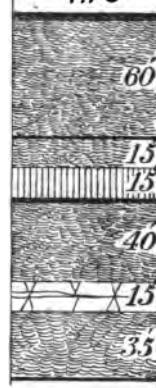
At the bridge over Wolf Creek two miles south from New Hope mills the Homewood Sandstone lies thirty-five feet above water level, and a thin coal seam belonging to the Mercer group is seen near the creek bed.

Mr. McKnight gives the following,—(see Fig. 79) as an approximately correct description of the measures exposed near his mill.

McKnight section.

Coal [Kittanning Middle],	3'
Shale,	60'
Coal [Kitt. Lower or Ferriferous],	1' 10"
Shale,	15'
Ferriferous Limestone,	15'
Coal [Scrubgrass],	2' 6"
Shale,	40'
Sandstone [Homewood],	15'
Shale,	35'
Coal [Mercer] at water level,	1' 16"

V.79



Two miles farther down the creek, there is a beautiful exposure of the Clarion Group, in an almost vertical bank on the west side of the stream. The Clarion bed is about a foot and a half thick and lies at water level. It is of excellent quality and was for many years dug with mattocks from the creek bed.

The Scrubgrass Coal was seen immediately underlying the limestone, but as its outcrop was inaccessible on account of the steepness of the creek bank, its thickness was estimated by the eye.

The measurements made from these exposures are shown in Fig. 80, as follows:

Wolf Creek section.

Slate.	
Kittanning Lower? (Ferrif. Coal?), 2' 6"	
Slate,	10'
Ferriferous Limestone,	15'
Scrubgrass Coal,	2' 6"
Slate,	30'
Clarion Coal,	1' 6"

V.80



The bed overlying the limestone by only ten feet was not seen, but is said to have been opened at several places in this neighborhood. It lies entirely too low for the Lower Kittanning bed, and is probably the Ferriferous Coal. If it be identical with the former, we can only account for its nearness to the Ferriferous Limestone, by supposing that an ancient erosion denuded the shales underlying it.

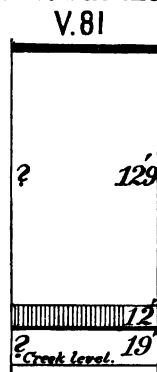
The Scrubgrass bed is reported to yield an excellent coal but is nearly always too thin too mine. It is quite persistent in the adjoining portions of Mercer and Lawrence counties.*

Going southward to the mouth of Wolf Creek, a distance of about two miles, the stream falls nearly as much as the rocks dip, so that the Limestone is there found twenty feet above creek level.

The section shown by Fig. 81, shows the position of the Kittanning Upper Coal bed at Mr. Crocker's bank.

Crocker's Coal Bank Section.

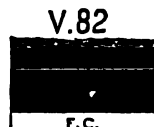
Kittanning Upper coal,	3' 3"
Concealed,	129'
Ferriferous Limestone,	12'
Scrubgrass Coal,	1' 3"
Concealed to stream,	19'



Another bank has been opened on the Thompson farm, a short distance from the Crocker opening. In both of these banks the coal is quite pyritous. At the latter opening a measurement gave: (Fig. 82.)

Crocker's Coal Bank.

Shale roof.	
Coal,	1' 0"
Bone,	1"
Coal,	2' 2"
Fireclay.	



A comparison of the above measurement with that of the Kittanning Middle bed, (Fig. 76,) discloses a striking similarity in structure between the two coals. This is so noticeable, that at one time I was led to think the two were one and the same bed, but the Harrisville Coal is only from 70 to 90 feet above the Ferriferous Limestone, and can be traced into central Butler as the equivalent of the Kittanning Middle bed, whereas this coal lies 129 feet above the limestone, and occupies therefore the horizon of the Kittanning Upper

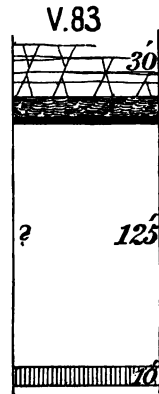
*The Scrubgrass coal, as already indicated in Chapter IV, is probably a split from the Clarion coal bed, but throughout Mercer, Lawrence and Venango counties it is always widely separated from that bed and must be regarded as a separate seam.

coal as seen at Stone House and many other places in the county.

The Kittanning Upper coal is also opened in the southeastern part of the township on the farm owned by Mr. John Keister where it is about one hundred and twenty-five feet above the Ferriferous limestone as shown in Fig. 83.

Keister Section.

Massive (Freeport Lower) sand-	
stone,	20' to 30'
Shale,	0' to 10'
Kittanning Upper Coal,	3'
Concealed,	125'
Ferriferous Limestone,	10' (?)

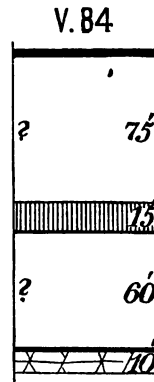


The Ferriferous Limestone has been laid bare at several places in this neighborhood, but its total thickness could nowhere be seen. It always measures at least seven or eight feet, and probably in some places is very much thicker. A quarry is now in operation on the Wigton farm not far from Keister's Mill. The bed plates there show their usual irregularly undulating surfaces.

About two miles farther down the Slippery Rock, at Wick's Mills the section shown in Fig. 84 was compiled.

Section at Wick's Mills.

Kittanning Middle Coal,	3'
Partly concealed,	75'
Ferriferous Limestone,	15'
Scrubgrass Coal, reported.	
Concealed,	60'
Coal—Brookville Bed,	2'
Homewood SS. to water level,	10'



The Kittanning Middle Coal is opened north of the mill, by Mr. Geo. Christley. The Ferriferous Limestone has been quarried in the hollow close to this bank, and in many other places in the same vicinity. Its outcrop is also frequently seen on the roads in this neighborhood, and in nearly all of the hollows running up from the creek.

On the road close to Wick's mill the outcrop of a coal bed is exposed, which lies in the horizon of the Brookville Bed. It is apparently about two feet thick. Beneath it is the Homewood Sandstone, which is here a rather irregularly bedded rock.

§59. *The Wolf Creek Oil and Salt Testing Company.*

The subjoined record of a well drilled by this company in search of oil, gas, or salt water, was furnished by Mr. Kingsbury, of Centerville.

The company started their first well in 1870, but after drilling it to a depth of from 800 to 900 feet, a heavy flow of gas was struck, which effectually stopped them from drilling any deeper. The tools got fast in the hole, and two sets of fishing tools were lost in the well before it was finally abandoned. It is said that at one time the gas threw a column of water over one hundred feet above the derrick floor. It was subsequently used in drilling their No. 2 well, which was started the succeeding year, and of which the following is claimed to be a correct record :

Wolf Creek Well No. 2. (Fig. 85, Plate VI.)

Drilled in 1871. Located in a hollow near Wolf Creek, two miles northwest of Centerville. Commences to drill in the Ferriferous Limestone.

Conductor—in limestone,	6' to	6
Slate and shale,	102 to	108
Sand,	35 to	143
Slate,	20 to	163
Sandstone,	157 to	320
Slate,	105 to	425
Sandstone,	35 to	460
Shale,	200 to	660
Sandstone,	20	} 95 to 755
Sandstone,	75	
<i>Red Rock</i> ,	80 to	835
Sandstone, (measured at 846',)	11 to	846
Slate,	231 to	1077
Shell—oil show, (measured at 1080')	5 to	1082

Shale,	50 to 1132
Grey Sandstone,	20 to 1152
Slate,	90 to 1242
Red (slate?) (measured at 1300',)	80 to 1322
Black Slate,	100' to 1422
?,	1 to 1423
Total depth of well, (measured,)	— 1423

Cased at 540'. No oil was obtained, though a slight show was found in a shell at 1080 ft. The gas is still flowing, though quite feebly. The casing has been drawn from the well.

The principal geological features shown by this record will be discussed in Part II. Mention is also made of its bearing upon the geology of the oil rocks of Western Butler, in Chap. X.

§ 60. *Cherry Township.*

This township lies east of Slippery Rock, and north of Clay township. Its summits are somewhat higher than those of the former, but its surface is rendered quite irregular by the many valleys and ravines cut by the Slippery Rock and its tributaries. The two branches of this stream run through it, and enclose between them a very high sharp ridge, which ends in an abrupt nose at their junction, near the western line of the township.

Much bottom land is found on both branches of the Slippery Rock, but this is especially noticeable on the north branch.

The highest rock of the township (excepting, perhaps, a small area near its southern line, where the Upper Freeport coal is caught in the highest land,) is the Upper Freeport Sandstone, and the lowest is the Homewood Sandstone—the top of the Beaver River or Conglomerate Series. The latter rock is frequently seen near water level, along Slippery Rock creek and its branches. A short distance above it some trace of the Ferriferous Limestone can usually be detected, but the actual outcrop of this stratum is only seen in a few places.

The section shown in Fig. 86 was made from exposures observed in the ridge, at the confluence of the north and south branches of Slippery Rock creek.

Section at Slippery Rock Forks.

Kittanning Middle Coal,	blossom.	?	30'
Concealed,	50'		
Kittanning Lower Coal,	blossom.	?	30'
Concealed,	30'		
Feriferous Limestone,	10' to 15'		15'
Shale and shaly sandstone, . . .	20'		
Clarion Coal,	2' 10"		15'
Shale and shaly sandstone, . . .	15'		
Homewood Sandstone, massive, to flat,	30'		30'

V. 86

The Kittanning Middle Coal was only seen at its outcrop on the road. One mile and a half east of this locality, near the South Branch the bed is opened and mined on the Galloway farm, where a measurement gave the structure shown by Fig. 87.

Galloway coal bank.

Thin bedded sandy shale roof.

Coal,	1' 11"	V. 87
Slate,	2"	
Coal, (seen,)	6"	

It is of fair quality, but mines in quite small pieces. The same bed is also opened on the farm owned by Mr. B. Grossman, and shows about 2' 6" of good coal, with but little slate or sulphur. Near Five Points Mr. Perry has a bank on what appears to be the same seam, but it is most probably the Upper Kittanning coal. Its mouth is now closed, and no examination of the coal was possible.

The smut of the Kittanning Lower Coal is seen in several places on the road near Mr. Bryan's house, but is too thin to be of any value. It lies from 30 to 35 feet above the Feriferous Limestone. The latter rock is finely exposed in an excavation made for laying a foundation, near the residence of Mr. J. S. Bryan, who says that its total thickness is 14 or 15 feet.

In the summer of 1877 a well was drilled for oil on the

flat between the creek and Mr. Bryan's house. It started at about 70 feet below the Ferriferous Limestone and is said to be 1180 feet deep. No record was kept of the strata passed through; no oil or gas was found.

The Clarion Coal bed has been opened at a bank near School House No. 4 a short distance northwest from the mouth of McMurry's Run. No coal has been taken from it for some time past, and the entry is now partly closed. A measurement made near its mouth gave (see Fig. 88.)

Cherry T. Sch. House bank.

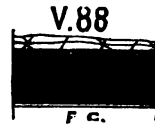
Sandstone roof.

Draw slate, 3"

Coal, 2' 6"

Slate, 1"

Fireclay floor.



The coal is of medium quality, and were it a little thicker mining from it would be profitable.

On the road leading south from Annandale, and between that town and the South Branch of Slippery Rock Creek, the exposures shown by Fig. 89 were observed.

Annandale section.

Kittanning Lower Coal—blossom, 1½' to 2'

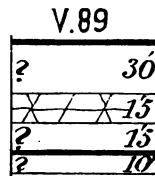
Concealed, 25' to 30'

Hard massive sandstone, 15'

Concealed, 15'

Clarion Coal—blossom, 2'

Concealed to Creek, 10'

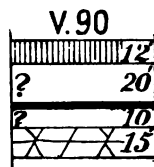


No trace of the Ferriferous Limestone could be detected. It is apparently cut out by an ancient erosion and its place filled by the lower part of the hard massive sandstone that lies fifteen feet above the Clarion coal bed.

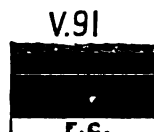
The latter bed is opened by Mr. Robert Black one mile southwest of Annandale where the coal is rather poor, containing many thin layers of slate from the thickness of a sheet of paper to a quarter of an inch. Other exposures observed in this vicinity give the section illustrated by Fig. 90:

Section at Black's bank.

Ferriferous Limestone,	12'
Concealed,	20'
Clarion coal,	3'
Concealed,	10'
Homewood Sandstone, (seen,) . . .	10' to 15'

*Black's coal bank. (Fig. 91.)*

Shale roof.	
Coal, bone, and slate mixed,	9"
Coal,	2' 5"
Fireclay floor.	

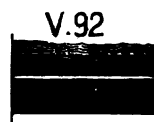


The Ferriferous Limestone has been quarried and burnt on the place owned by Mr. McGregor, where about eight feet of the stone can be seen, but at an outcrop on the road near Mr. Black's fully twelve feet of it is laid bare. It yields a very fair lime, but has not been quarried very largely.

The Kittanning Upper Coal is opened in the southeastern part of the township, near Five Points, by Mr. H. D. Hockenberry, at whose bank the bed exhibits the structure shown by Fig. 92:

Hockenberry coal bank.

Shale roof.	
Draw slate,	3"
Cannel coal,	9"
Slate,	2"
Cannel and bituminous coal,	1' 9"



The quality of this coal is very poor, and but little of it has been taken out. The lower bench is composed of alternating layers of mineral charcoal, cannel coal and bituminous coal.

Its position with reference to the underlying strata, is shown in Fig. 93.

The Ferriferous Limestone is exposed near water level at a quarry situated on the road running east from Five Points, and a few rods east of the Cherry township line. It will be described in connection with the geology of Washington township. A short distance from this quarry the smut of the Kittanning Lower Coal was seen on the road, at

an elevation of 45 feet above the top of the limestone. It is too thin to mine.

Section at Five Points.

Coal blossom—"Currie Local Coal," thin.
 Sandstone and shale (Freeport SS.) . 50'
 Kittanning Upper Coal, 3'
 Shale—containing Kitt. Mid. Coal, . 65' (?)
 Kittanning Lower Coal, 1' 6"
 Sandstone and shale, 45'
 Ferriferous Limestone, 10'

The interval between the Kittanning Upper and Lower Coal beds is possibly a little larger than the thickness assigned it in the above section, and an addition of about ten feet to correct for the error occasioned by dip, would probably make the section more accurate. Near the summit of the road leading to Five Points, a thin coal seam outcrops, which is rather too low for the Freeport Lower coal, and is probably the representative of the Currie Local bed. It overlies the Kittanning Upper Coal about fifty feet.

V. 93



§ 61. *Washington Township.*

This township lies east of Cherry and north of Concord township.

It is nearly all occupied by high land, with summits ranging from 1500 to 1575 feet above ocean level. The only low lands it contains are found in the valleys of the north and south branches of Slippery Rock Creek, in the northern and southwestern portions of the township.

The Allegheny and Beaver dividing ridge, runs through it, passing close to North Washington and Annisville, with a branch divide sweeping off to the west from Parsonville between the waters of the two branches of Slippery Rock Creek.

There is some quite good farming land on the summit ridges, some of which is greatly improved by the disintegration of the Upper Freeport Limestone. The soil occupying the side hill slopes is seldom a satisfactory one to cul-

tivate, being formed principally from the outcrop of the Freeport Sandstone.

The township contains within its limits all of the rocks of the Upper Productive Coal Measures, from the Upper Freeport coal, which occurs on the highest summits, down to the Homewood Sandstone, which is frequently exposed in the valley of the North Branch.

The Freeport Upper Coal is caught in nearly all the summits, but is never of workable thickness, and often so thin that its presence can scarcely be detected, and sometimes no trace of it can be discovered.

The Freeport Lower Coal has an enormous thickness at North Washington, sometimes measuring nine feet of solid coal. A development similar to this is described in the report upon Parker township, where this coal is sometimes thirteen or fourteen feet thick. Over most of the township, the bed is from two to four feet thick, and of medium to fair quality.

The Currie Local Coal has a limited area of workable thickness, southwest of North Washington.

The Kittanning Upper Coal is present as a valuable bed of cannel coal. It is rather thin, but of excellent quality. The following analysis was made by Mr. McCreath, from a sample of this coal as prepared for sale at the banks. The bed has a similar character in the vicinity of Murrinsville, in Marion and Venango townships, but in both these localities its extent is quite local, and the available area comparatively small:

McGarvey Cannel Coal.

Water,	1.610
Volatile matter,	40.300
Fixed carbon,	49.456
Sulphur, . . . . .	.739
Ash, (cream color,)	7.895
	<hr/>
	100.000
	<hr/>
Per cent. coke,	58.090

The Kittanning Middle Coal is not usually a bed of workable size in this township.

The Kittanning Lower Coal is from one and a half to two and a half feet thick, and is not being worked within the township limits at present, but in the future will probably prove quite valuable. It lies about forty feet above the Ferriferous limestone.

The Brookville and Clarion Coal beds are found near water level in the northern part of the township, on Slippery Rock creek, where they have been opened by Mr. Burnett, who has kindly furnished the following section (shown in Fig. 94) which compiled on the south bank of the creek:

Burnett south Section.

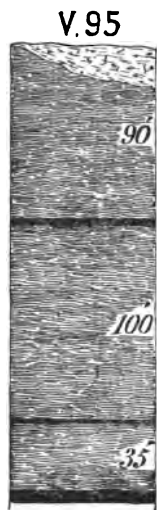
"Earth and slate,	60'
Coal,	3'
Slate,	90'
Coal,	3' 10"
Slate,	120'
Coal,	2'
Slate,	32'
Coal,	3' 10'"



The lowest coal of the above section has been opened. It is quite free from sulphur, and much cleaner than the bed worked on the north side of the creek. This bed is probably the Brookville, and the one overlying it the Clarion Coal bed, but the absence of the Ferriferous Limestone from the section makes this identification rather uncertain. The bed overlying them 120 feet is evidently the Middle Kittanning, but its thickness is probably ever estimated.

Burnett north Section.

"Earth and slate,	90'
Coal,	3'
Slate,	100'
Coal,	2'
Slate,	35'
Coal,	5' 6'"



Mr. Burnett gives the section shown in Fig. 95, as a description of the measures found on the north side of the creek.

The lowest coal bed of this section is opened and worked. A large amount of coal has been taken out, and, though it is rather pyritous, has found a ready sale for rolling-mill and boiler use at Cleveland, where it is shipped by the Shenango and Allegheny R. R. Near the centre of the bed is a bad bony parting about three inches thick, but the bed is such a large one that it can be profitably mined, notwithstanding these drawbacks.

The Freeport Lower Coal is opened at Smiths' Bank, half a mile northwest from North Washington, where it has an abnormal size. It has been worked for a period of twenty years or more, and during that time a very large amount of coal has been mined from it. Several drifts have been driven in, but one after another has fallen shut, and at present there is but one entry in good condition. This is well built and high enough to allow the use of mules in the bank.

In some parts of the old workings the bed contains nine feet of solid coal with no partings of slate or bone, but its average thickness is from six and a half to seven feet. A bad horseback was encountered in one part of the bank, but it has been cut through and is not of very great width.

In that part of the hill from which the coal is now being mined, it shows the structure represented in Fig. 96.

Smith's coal bank.

Shale roof.

Draw slate, 4" to 6"

Coal, (sulphury,) 2' 6"

Coal, fair, 4' 5"

Slate, 1' to 1' 6"

Fireclay.

V.96



The upper bench is quite variable in thickness, and of inferior quality, being rather pyritous and filled with thin slaty laminae. Up to the present time it has usually been left in the bank as a roof.

The lower bench is of good quality and mines in very

large, compact lumps. It is much more constant in thickness than the former, ranging from four to five feet, and never measuring less than four feet except where cut out by the horseback.

This bed has been sought after in all of the surrounding hills, but it is everywhere much thinner than at the Smith Bank, showing that this abnormal development is quite circumscribed, and that it can have no connection with the similar development occurring in Parker township. In the southwestern part of the township it is often seen in blossom on the roadside, but is nearly always too thin to be of any value.

§ 62. *North Washington Cannel Coal.*

This bed is the same with the Kittanning Upper Coal,—the Darlington Cannel Coal of Report Q. It is the best coal found in this township.

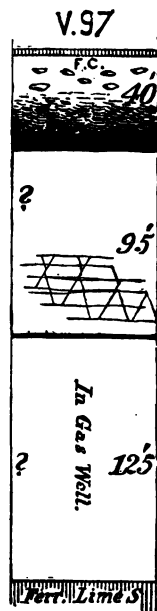
The area over which it of workable size is quite small, and is situated about one mile south by west from North Washington.

It underlies the Freeport Upper Limestone about one hundred and thirty to one hundred and forty-five feet, and is about one hundred and twenty-five feet above the Ferriferous Limestone as determined from the Jack Farm Gas Well record.

North Washington section.

Freeport Upper Limestone,	3'
Concealed: with fireclay and ore balls,	40'
Freeport Lower Coal,	4' to 9'
Concealed (Freeport SS.)	95'
Kittanning Upper (Cannel) Coal,	2'
Unknown, <i>in gas well</i> ,	125'
Ferriferous Limestone, in well,	—

The section illustrated by Fig. 97, shows its position in the measures. The Lower Freeport Coal in this description lies some-



what higher than its usual place in the measures, giving about twenty feet more space to the Freeport Lower Sandstone than that rock generally occupies.

The following gentlemen have opened banks upon the cannel coal bed: Mr. Wm. C. Graham, Mr. Henry Shain, Mr. McGarvey (2) and Mr. D. F. Campbell.

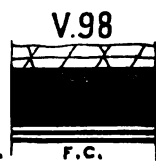
The subjoined measurements,—illustrated by Fig. 98,—show the structure of the bed.

McGarvey Bank No. 1.

Cannel Slate,	3" to 1' 10"
Cannel Coal,	1' 10" to 2' 4"
Slate (floor)	

Bank No. 2.

Cannel slate,	4" to 1' 0"
Cannel coal,	2' 3"
Slate (floor)	3"
Coal (reported)	2"
Slate "	3"
Coal "	2"



Fireclay.

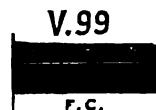
It has usually a changeable roof of sandstone or slate.

The coal has a clean, slightly conchoidal fracture, but mines in nearly cubical blocks, contains a very small percentage of sulphur, and leaves but a moderate amount of ash. An analysis of a specimen taken from the McGarvey Bank No. 1 has already been given on page 106.

The same bed is opened in the southwestern corner of the township by a new bank on the farm owned by Mr. Wm. C. Glenn where a measurement gave the structure shown in Fig. 99.

Glenn coal bank.

Slaty shale roof.	
Semi-cannel coal,	6"
Thin bony parting,	—
Coal,	1' 6"



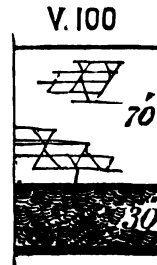
Fireclay floor.

The coal is of fair quality, and mines very nicely though the entry is in but a short distance. In some places the upper bench becomes a true cannel coal, but it is usually

of a semi-cannel character and rather poor quality. This bed is undoubtedly the same with the North Washington Cannel coal bed. The measurements given in Fig. 100 were made near this bank.

Section near Glenn's bank.

Freeport Lower Coal,	blossom.
Concealed, with shaly sandstone,	70'
Kittanning Upper Coal,	2'
Concealed—shale,	30'
Kittanning Middle Coal,	3'



The Kittanning Middle bed was opened some years ago, by an old bank one mile north from the Glenn opening. This coal was found at a depth of thirty feet in digging a water well near the latter bank, and underlies it thirty to thirty-five feet.

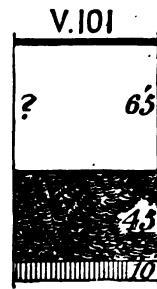
The blossom of the Freeport Lower Coal was seen near the summit of the road. It is hardly of workable size.

The Kittanning Upper Coal was opened some years ago near Mr. Christy's house, two miles west of North Washington, but the bank has long since fallen shut, and no examination of it could be made. The character of the coal is probably similar to that found in the Hockenberry opening near Five Points in Cherry township.

On the road running from North Washington to Five Points, the exposures measured were—(Fig. 101:)

Section west of N. Washington.

Kittanning Upper Coal,	3' (?)
Concealed,	65'
Kittanning Lower Coal,	2'
Concealed—sandy shale,	45'
Ferriferous Limestone,	10'



A quarry is opened on the Ferriferous Limestone near the bridge over the South Branch of Slippery Rock Creek. Only six or eight feet of the stone is visible, but its total thickness is about 10 to 12 feet.

§ 63. *The Jack Farm Gas Well.*

This well is located on the Jack Farm, near the Butler road, and about half a mile south of North Washington. The derrick floor is but a few feet below the mouth of an old coal bank on the Lower Freeport Coal Bed.

The Ferriferous Limestone was reached at a depth of 205 feet, and gas was struck in the "Fourth" Sand near the bottom of the well, which is said to be over 1,500 feet deep. No record could be obtained of the strata passed through; probably none was kept.

When the gas was first struck it was sufficient to fire two large pumping stations, but has since then greatly diminished. It is at present used in the pumping station of the United Pipe lines north of town, where it is conveyed through pipe-line pipe laid for that purpose.

This well is an isolated one, and the reservoir of gas from which it draws its supply can have no other vent, unless we admit the possibility of an unobstructed connection between the sandrock here and that of the oil producing area at Fairview or Martinsburg, five miles away. We should not have expected therefore that the supply would decrease (as reported) one half in quantity in one year.

The gas well on McMurry's Run in Marion township is also an instance of an isolated well rapidly falling away in production. In this case we may partly attribute its decrease to the presence of a large body of fresh water which constantly flows into the well from a stratum above the gas rock.

§ 64. *The Rumbaugh Oil Wells.*

The well now pumping is situated on the Rumbaugh Farm two miles northwest from North Washington, and commenced to drill at about five feet above the Upper Kittanning Coal bed. The Ferriferous Limestone was struck at 125 feet, and the oil bearing rock at either 1265 or 1365 feet. The former depth is probably the correct one.

Mr. Wm. Shira who owns and resides upon the adjoining farm, states that the First or Old Rumbaugh Well was

drilled in 1873, at the time that the Troutman Well was being drilled at Modoc City; that oil was found at 1375 to 1380 feet, but that the well was drilled to a depth of 1690 feet with no increase. The oil rock found at 1375 (?) feet (1275?) is said to be an excellent loose pebbly sand. The well was pumped for several weeks and yielded about seven barrels per day from this horizon, but as the oil had to be hauled to Parker, and as the price of oil was not sufficient to pay the expense of teaming and pumping the well was abandoned.

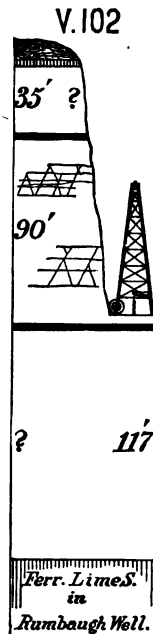
Three dry holes have been put down in this vicinity; one on the Thompson, and one on the Hilliard Farm, and one on the South Branch of Slippery Rock Creek. They are all located *west* of the "belt line" on which the Rumbaugh wells are located.

Two years ago Messrs. Trumbull and Croll, firm in the belief that a good sand was found in the old well, and encouraged by the high price of oil, started and finished the second well on the Rumbaugh Farm, which is the one now producing. It is said to yield from three to four barrels per day. This well is also located *west* of the old well. It is possible that in the future oil may yet be found in paying quantities in this neighborhood, but if any good wells are obtained, it seems most probable that they will be found *east* of the line on which the old well is situated.

Rumbaugh section.

Shale,	10'
Freeport Upper limestone,	3'
Concealed,	35'
Freeport Lower coal,	3'
Concealed to well mouth, containing hard massive Freeport sandstone, . . . 20' }	90'
Shale,	5'
Kittanning Upper coal,	3'
Unknown—in well,	117'
Ferriferous limestone.	

8 V.



The section shown in Fig. 102, was compiled from exposures near the well on the Shira and Rumbaugh farms.

The oil is of 45° gravity (Baumé), green in color, and very much resembles the Oil Creek oil, having a lighter and more decidedly greenish tinge than either the Butler or Bullion oil.

The Kittanning Upper coal bed is opened at two banks on the Rumbaugh farm, close to the pumping well, and about five feet below its mouth. The coal is rather soft and slaty, but is said to burn very freely. It measures: (Fig. 103.)

Rumbaugh coal bank.

Shale roof.

Coal,	10"
Slate,	3"
Coal,	1' 6"

V. 103



Fireclay floor.

The Freeport Lower coal was opened in a bank, on the Shira farm, where it is reported to be from 3' to 3' 6" thick. The bank is now closed, and no measurement of the bed could be made. Mr. Shira says that it is quite pyritous, but contains little or no slate.

The presence of the Upper Freeport limestone is shown by nodules and fragments on the road, and scattered over the fields at the height of about thirty-five feet above the coal bank. The Upper Freeport coal is not caught in these hills, but it may be found in the small round top near Mr. Shira's house.

§ 65. *Parker Township.*

This township lies north of Fairview and east of Washington townships, and adjoins Perry township, of Armstrong county, on the east.

Its central and western portions are occupied by high land, but the contour of its surface is, in general, quite irregular, being gorged by the ravines of many small tributaries to Bear creek and its branches.

The valley of the North branch of Bear creek is a sharp,

deeply cut ravine, exposing the measures underlying the Homewood sandstone. The South branch has eroded down to the same rock at Martinsburg. From the latter locality, eastward, the stream falls quite rapidly, so that at Donnelly station, near the county line, it runs over the middle portion of the Conglomerate series (No. XII) or "Mountain Sand group."

The "Fourth sand oil belt" does not touch the township, but the "Third sand belt" traverses it from Lawrenceburg to Argyle, in a straight line, bearing S. 22° W. In the neighborhood of Martinsburg, much oil has been obtained from the "Thirty foot rock," and some has also been found in the "Fifty foot rock." The wells that find their oil at these horizons are located on lines running parallel to the trend of the "Third Sand belt," but are situated west of the town. A description of these rocks, showing their position with reference to the Third and Fourth sands, will be found in chapter X.

The section shown in Fig. 104 was compiled from a series of exposures noted along a surveyed line from Columbia Hill, in Allegheny township, to Donnelly station, and can be regarded as a typical section of the rocks found within the limits of this township. Some alterations have been made in the original measurements to eliminate the error produced by dip, and the intervals as here given are very nearly correct.

The Freeport Limestone and coal beds are absent where this section was obtained. The Lower Freeport coal which is an enormous bed in the south-western corner of the township, is seldom seen on its eastern border and is always too thin to mine.

The Kittanning Lower Coal bed has been mined near Lawrenceburg, but is not of good quality, and only a comparatively small amount of coal has been taken from it. Most of the coal used at Parker and Lawrenceburg is obtained from the Clarion Coal bed. This coal is of inferior quality, being quite pyritous, but it is of good workable size, and easily accessible. A large quantity has been taken from it for use at the oil wells.

Parker Section.

Surface: place of Freeport Upper		V.104
Limestone and Coal,	30'	
Sandstone, thin bedded, fine grain- ed, (Upper and Lower Freeport Sandstone,)	75'	
Coal, worthless, "Currie Local Coal,"	1' to 2'	
Slate and slaty shale, olive and grey,	75'	
Kittanning Middle Coal,	2'	
Concealed,	34'	
Kittanning Lower Coal,	2' 6" to 3'	
Fireclay, 3' to 6',	5'	
Concealed,	35'	
Shale,	8'	
Ferriferous Limestone,	15'	
Dark shale,	30'	
Clarion Coal,	3' 8" to 4'	
Concealed,	22'	
Homewood Sandstone, "60 foot rock," massive,	15'	
Shale and slate,	50'	
Bituminous shale, sometimes im- pure (Mercer) coal,	3'	
Sandy fireclay,	12'	
Blue slate,	5'	
Bituminous shale or impure coal, (Mercer Group,)	5'	
Olive shale and blue slate with nodular ore near top,	47'	
Shaly Sandstone,	20'	
Blue and olive shale, with a band of bituminous shale and fireclay,	43'	
Sandstone, thin bedded to creek level at Donnelly Station, . . .	20'	

The Ferriferous Limestone has been quarried and burnt in small quantities for agricultural and building purposes at many places near Columbia Hill and Parker's Corners.

It is of its usual character, yielding a fair lime, and is accessible on its line of outcrop at almost every place in the township. The annexed topographical map of Parker (plate II,) shows the outcrop of this stratum and of the Clarion Coal bed.

§ 66. *Mercer Group.*

In the lower part of the preceding section two bands of bituminous shale are shown, lying about seventeen feet apart. In some places they are true beds of impure coal, though always entirely unfit for mining. They are the representatives of the Mercer Group of coals and limestones, which is a very valuable series in Mercer and Lawrence counties. The iron ore of this group is also present, and has been mined for use in the old furnace on Bear Creek.

Beneath this ore band and between it and water level at Donnelly Station, there occurs a very variable alternation of shale, slate, fireclay and sandstone, with a band of bituminous shale near the middle of the mass. This whole interval is sometimes occupied by a massive sandstone, which may suddenly disappear entirely, again giving place to shaly and slaty measures. In the cutting made for the Parker elevator there is exposed 120 feet of massive sandstone filling all of this interval. The sandstone from top to bottom is a hard, evenly grained, massive, greyish rock, and is evidently much thicker than the 120 feet exposed by the excavation. Other exposures measured within the city limits show that there is from 150 to 160 feet of solid sandstone, with no partings of shale or slate, lying between the base of the Mercer Group and water level in the Allegheny river. It undoubtedly corresponds to the Upper and Lower Connoquenessing Sandstones of the Beaver River Series; the middle member of the Conglomerate Series.

The Ferriferous Limestone outcrops on the road from Lawrenceburg to Eldorado, about one half mile beyond Parker's Corners. It has been quarried from the roadside, but only about three feet of it, overlaid by ten feet of shale, can now be seen.

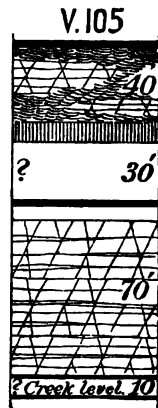
The Kittanning Lower Coal bed is opened and mined from a bank close to the quarry, and forty feet above it. The coal is here of about the same character as at Lawrenceburg.

At the crossing of this road over the North Branch of Bear Creek, one of the Mercer Coal beds is laid bare at the road side. It ranges from a few inches to nearly two feet in thickness, but is of quite poor quality and too thin and variable to be worth opening. It has a fireclay floor and a roof of grey sandstone. The latter may be considered as the base of the Homewood Sandstone, which is a massive rock jutting out in bold cliffs along the stream, and shows a rather unusual thickness in this vicinity.

The above described exposures give the section shown by Fig. 105 as follows:

Bear Creek section.

Kittanning Lower coal,	2'
Concealed—SS. and shale,	40'
Ferriferous limestone,	10'
Concealed,	20' to 30'
Clarion coal,	3'
Concealed,	8'
Hard massive SS., . 20' } Homewood {	70'
Sandstone and shale, 50' } Sandstone, }	
Grey shaly sandstone,	10'
Mercer coal bed,	1'
Concealed to creek,	10'



The Clarion Coal has been opened and worked at a bank near the mill, but the entry has fallen shut and the bed could not be seen. It is said to be about three feet thick, and of medium quality.

The Freeport Lower Coal has been opened at several places between Eldorado and North Washington, in the western part of the township, but nearly all of these banks have been abandoned. The bed lies in the hill tops, with little cover, but is said to be usually of good workable size, though the coal mined from it is quite soft. Its blossom is also frequently laid bare on the road from Six Points to Martinsburg in the central part of the township. It here

varies from two to three feet, and is overlaid by the Upper Freeport sandstone which sometimes measures as much as thirty feet.

The section shown in Fig. 106 was compiled from a series of exposures near Martinsburg by means of several surveyed lines of levels.

Martinsburg section

Kittanning Upper (Cannel) Coal, 1' 2" to 1' 4"	
Fireclay, about	2'
Slate	50'
Kittanning Middle Coal,	2'
Fireclay,	4'
Slate and shale,	60'
Ferriferous Limestone,	4'
Soft slaty shale,	14'
Clarion Coal,	7'
Fireclay,	2'
Shale, with nodular ore,	9'
Homewood Sandstone hard and massive, to level of Creek at trestle,	20'

V. 106



The Kittanning Upper and Middle (?) Coal beds are both opened and worked by the Parker and Karns City R. R. Co., in the ravine near the big trestle. They are rather thin beds, but yield a fair quality of coal. The Kittanning Lower Coal is absent in this locality. The Kittanning Middle bed lies quite low in the above section, but this may be partly owing to the violent south dip of the rocks into the Martinsburg Synclinal axis.

The Ferriferous Limestone is quite variable in this vicinity. In the cutting at the R. R. station it is only four feet thick, but many of the oil wells drilled near town are said to have found from fifteen to twenty feet of it. On Bear Creek, near the mouth of Story Run and just before its final disappearance beneath water level, it is about eight feet thick, and on Big Bear Creek, near the mouth of Silver Creek, it measures fifteen feet. Throughout all of this area its overlying ore band is either very thin or altogether absent.

The blossom of the Upper Kittanning Coal is seen on the road running out of Martinsburg to Six Points, at a height of 120 feet above the limestone.

The Clarion Coal bed is of quite unusual size at Martinsburg, but is of very poor quality, being filled with sulphur binders. It usually shows the structure shown in figure 107:

Martinsburg coal bank.

Upper bench,	4' 0"	} 7' 6"
Slate,	6"	
Lower bench,	3' 0"	

V.107



Going down Bear Creek, the central parting of slate constantly increases, until near Stone House, the beds consist of, (Fig. 108.)

Stone House coal bank.

Upper bench,	2' 6"	} 13' 6"
Slate,	6' 6"	
Lower bench,	4' 6"	

V.108



The upper bench is thinning away in this direction, so that at Lawrenceburg it is only one foot and a half thick, and lies fifteen feet above the lower bench, which is four feet thick in that vicinity.

We here have then, an instance of a coal bed parting into two separate beds, or, *vice versa*, if we put it the other way, two beds converging into one. The above data are more clearly illustrated by Fig. 3, in chapter IV, where a fuller description of these intervals will be found

§ 67. *The Martinsburg Axis.*

The old coal bank, near the water tank, is opened directly on the axis of this synclinal, and the spring from which the tank is supplied issues from the lowest part of the limestone, in the trough of the flexure.

The north dip may be easily detected by the eye, from the difference in elevation of the Clarion Coal bed at the tank, the station, and on the railroad south of the depot.

The following elevations of the top of the Ferriferous

Limestone show its rise and fall in crossing the flexure from north to south :

NORTH.	<i>Synclinal.</i>	<i>Anticlinal.</i>	SOUTH.
Gully at Company's Banks.	At Tank.	At Station.	Along R. R. On Creek.
1152'	1120	1135	1145 1124

South dip.

North dip.

South dip.

From the crest of the anticlinal to the centre of the Synclinal trough the distance is less than half a mile.

At Martinsburg the Homewood Sandstone passes under water level, but from this point eastward to the Allegheny River it is constantly in view in the valley of Bear Creek, as a hard massive sandstone, making bold escarpments wherever the erosion has been sharp, and forming a prominent terrace where the contour is smooth. It varies from ten to fifty feet in thickness, but usually measures about thirty feet. It here lies close to the Ferriferous Limestone, occupying the horizon at which we should expect to find the Brookville coal bed. Nearly all of the oil well records obtained in this and Fairview townships show it in about the same position. It is usually called the "sixty foot rock" by the drillers," who can nearly always recognize its sand-pumpings.

Gibson and Ecock well section.

Well mouth above ocean in feet, 1382.	
Clay, (conductor,)	14'
Surface sandstone,	15'
Slate—place of Freeport Upper coal and lime,	51'
SS. white—Freeport Upper Sandstone,	7'
Coal—Freeport Lower,	3'
SS.—Freeport Lower Sandstone, . . .	55'
Coal—Upper Kittanning,	5'
SS., (fireclay ?)	3'
Slate,	132'
Limestone—Ferriferous,	15'
Coal—Scrubgrass, (at 303',)	3'

V. 109



The section shown by Fig. 109 is the upper portion of the

record of the Gibson and Ecock well, (see Chap. X,) and is here reproduced, to show the character of the measures between Martinsburg and the Armstrong county line. The well is situated on the Fronsinger farm, due east from town.

A bed of coal six feet thick is noted in this record at a depth of 498 feet, but it is, without doubt, one of those bands of bituminous shale already described as seen in Bear Creek Valley, near Donnelly.

The record makes no mention of any coal or limestone corresponding to the Upper Freeport beds, and as it was very carefully kept, and sand-pumpings preserved from nearly every stratum, it is probable that they are wanting in that locality. The Columbia Hill Surface section, Fig. 104, exhibits the same feature.

The Freeport Lower coal is given a thickness of three feet, which is probably nearly correct; but the size of the Upper Kittanning coal is undoubtedly exaggerated, and the Scrub-grass coal, immediately beneath the Ferriferous Limestone, is also given too great a thickness.*

In the high land south of Silver creek, the Freeport Lower coal bed is opened and worked at the banks owned by Mr. Hugh Collins and Mr. McCafferty, where it has a development similar to that described at North Washington.

The bed here usually measures: (Fig. 110.)

Collins coal bank.

Slaty laminated coal,	4' 0"	} 9' 6"
Laminated coal,	1' 6"	
Coal,—fair,	4' 0"	

V.110



It is often much thicker than this, in some places swelling to 13 or 14 feet, but its average size is from $7\frac{1}{2}$ to $9\frac{1}{2}$ feet. Nearly all the variation takes place in the upper

*The coal beds passed through in drilling an oil well are nearly always reported to be much larger than they really are. This is due to the fact that when using the heavy tools now employed in drilling, very fast time is made, and the driller often may pass through the coal bed, and get into the underlying fireclay before he is aware of the fact; the coal and fireclay become thoroughly mixed, and as both are soft drilling, and as the fireclay comes up in the sand pump thoroughly blackened with coal, he thinks he is still drilling in coal, and consequently gives the combined thickness of both the coal and fireclay, as the thickness of the coal alone.

bench, generally by gradual augmentation of its size, by additional layers of coal, which always come in on top the bed. These upper layers are always quite impure, being filled throughout by thin laminae of slate; but no regular parting band of slate or bone is ever found in any part of the bed.

The lower bench yields a fair coal, mining in large sized pieces, and contains little sulphur. This is the only part of the bed that is worked, as it has been the practice to leave the upper bench in the bank as a roof. When any of the latter is taken out it always mines in slab shaped blocks, easily split *with* the lamination but quite tough in any other direction. This is due to the presence of the thin laminae of slate already mentioned.

The bank owned by Mr. McCafferty is worked by a shaft twenty-two feet deep, from which the coal is raised by horse power. It is thoroughly drained by old workings on the Collins Farm.

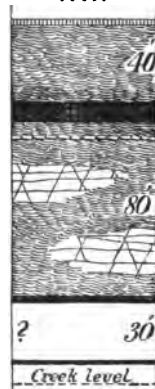
Diligent search has been made for this bed in all of the surrounding hills, but it is everywhere too thin to be profitably mined.

The Freeport Lower Ore occurs about ten feet beneath the horizon of this coal, and has been mined quite largely for use in the old Maple Furnace on North Bear Creek. It is said to vary from three to four feet in thickness, but only occurs in "pots" or local patches, and is not a persistent stratum. It is probably the representation of the Freeport Lower Limestone.

Section near McCafferty farm.

Freeport Upper Limestone, . . .	3'
Concealed—shale,	40'
Freeport Lower Coal,	10'
Shale,	8'
Iron ore (L. Free. Lime?)	3'
Concealed: SS. and Shale, . . .	80'
Kittanning Upper Coal,	3'
Concealed,	30'
Kittanning Middle Coal, blossom	
Concealed to Creek,	10'

V. III



The section shown by Fig. 111, was made from data gathered in this neighborhood.

In the hill above the Collins Bank, the Freeport Upper Limestone is detected by fragments lying on the surface at about forty feet above the coal. Its actual outcrop was not seen.

The two Kittanning coal beds were located in the above section from their blossoms exposed on the main road.

Southwest of Martinsburg the Kittanning Upper Coal is quite a good bed, and is of unusual size. At the bank opened on the Story Farm it shows the following structure: (Fig. 112.)

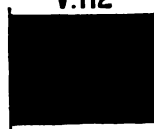
Story Farm coal bank.

Shale roof.

Laminated slaty Coal, 1' 0"

Coal, 4' 6"

V.112



This is much greater than the usual thickness of this bed,—which rarely exceeds three and a half feet,—and is remarkable for the absence of any well defined parting layers of slate or pyrites. It is possible that this coal may be the Currie Local bed, or simply a “stray” bed of local development, but as it lies one hundred and thirty-five feet above the Ferriferous Limestone its identity with the Upper Kittanning Coal appears to be the correct determination of its place in the coal rocks.

CHAPTER IX.

§ 68. *Fourth Tier of Townships.*

This constitutes the northern tier, and embraces Mercer, Marion, Venango and Allegheny Townships, which are all bounded on the north by Venango County. In Venango and Allegheny townships there is much high ground, but the general level of Mercer and Marion is much lower. The great Divide sweeps in a curve from Farmington, in Venango township, northwest to the county line, which it follows westwardly until near the Mercer township line, when it again sweeps to the north along the line of Mercer and Venango counties.

Over all of this area the Kittanning group of coals is always accessible, but it only contains workable beds in a few localities. The Upper Kittanning is generally quite thin,—though at Murrinsville it is an excellent bed of cannel coal,—while the Middle Kittanning is workable in the western part of the row, and the Lower Kittanning has its best development along its eastern line.

The Ferriferous Limestone can be found in many places, but is not turned to as great an advantage as it might be. If it were used to a greater extent on all of the soils made from disintegrated slate or shale, good results could not fail to follow, and the farming of the district would be put upon a much more remunerative basis.

The Clarion and Brookville beds are both opened and worked in many places, and are quite constant in character and thickness, but are both rather pyritous, and though their presence will never very much increase the value of the land, they insure for a long period an abundance of coal for local use.

No exposures of the Mercer group occur in these townships, as the erosion has not been deep enough to cut down

to its horizon. On Scrubgrass Creek, in Venango county, the coals of this group are apparently absent, and on Bear Creek they are little more than beds of bituminous shale. It is not likely therefore that they are here present as workable beds; but if they ever are found of sufficient size and pure enough to mine, they can be reached at any point by shafts of moderate depth.

§ 69. *Mercer Township.*

This lies in the northwest corner of the county, being bounded on the south by Slippery rock township, on the west by Mercer, and on the north by Venango county.

Its highest rock is the Freeport Lower Sandstone, and the Homewood Sandstone is the lowest stratum found within its limits. The latter is laid bare in the valley of McMurry's Run, in the eastern part of the township, and is described in the sections compiled in Marion township.

The township is all occupied by comparatively high land, with summits about 1400 feet above ocean level.

The Kittanning Middle Coal bed is the only one of value opened within its limits. This has been worked by Mr. Andrew Knapp at an opening near the Franklin road north of Harrisville, but the bank has long been closed, and the coal was not seen. It is also opened and worked in the same vicinity by Mr. William Cochran, at whose bank it is of fair quality.

The openings owned by Mr. William Brown and those on the farm of Mr. Alexander Brown, show about the same features as the Barnes Bank and will need no detailed description.

§ 70. *The Barnes Coal Bank.*

This bank is worked by the Mercer Mining and Manufacturing Company, and is situated close to the Harrisville R. R. Station, one mile and a half south of the town.

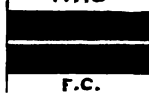
It has been worked quite extensively for a period of about eight years. A large area has been completely exhausted

and at the present rate at which the coal is being extracted, all the good coal will be taken out in about eight years from the present time. Most of it is sent to Cleveland for rolling-mill use.

It overlies the Ferriferous Limestone by from 70 to 80 feet, and is therefore the Middle Kittanning bed, and is overlaid by shale 40 feet thick, above which comes the Freeport Lower Sandstone. The latter makes no prominent marks in this vicinity, and is neither a hard nor a massive rock.

A generalized measurement of the coal is given in the following description, which is illustrated by Fig. 113:

Barnes Coal bank section.

Draw slate and coal,	2 " to 4 "	
Coal,	1'0 " to 1'3 "	
"Bone and sulphur,"	1½" to 2½"	
Coal,	1'4 " to 1'7 "	
Fireclay floor.		

The upper bench is always more pyritous than the lower bench, though neither is much troubled with sulphur. The following analyses, made by Mr. McCreath, will show the character of both benches:

	No. I.	No. II.
Water,	2.430	2.920
Volatile matter,	36.735	38.495
Fixed carbon,	47.858	54.138
Sulphur, . . . . .	.767	.842
Ash, (grey, red tinge,)	12.210	3.605
	<u>100.00</u>	<u>100.000</u>
Coke, per cent.,	60.835	58.585

No. I was made from a sample from the upper bench, which contained less sulphur than usual. Its heavy percentage of ash is accounted for by the presence of some of the draw slate which adhered to the upper surface of the specimen analyzed.

No. II was made from a sample taken from the lower bench, and is a fair average analysis of the coal from that bench.

The coal from both benches mines in large solid pieces from those parts of the hill having sufficient cover; but much of the coal taken out is soft outcrop coal, that will not bear handling very well.

§71. *The Harrisville Axis.*

The main entry of the Barnes Bank is driven in a south-westerly direction, on the south side of this axis, for a distance of 1500 feet, along which the coal falls (south dip) nearly 25 feet. At this point a gangway branches off to the northwest, and encounters a rise (south dip) of about 25 feet in half a mile, it then runs level for a short distance on crest of the axis, when it pitches to the north (north dip) for a distance of 2000 feet to the end of the gangway, near the outcrop line of the coal. The centre of the synclinal is not reached in the bank, as the bed outcrops before going that far northwest of the anticlinal. It is, however, well defined by exposures near the mouth of Wolf Creek, a description of which has already been given in connection with the geology of Worth and Slippery Rock townships.

The Ferriferous Limestone has been quarried for many years from an exposure in a hollow formed by a small tributary of Wolf Creek, on the Pittsburgh Pike, three fourths of a mile south of Harrisville. A kiln has lately been erected at the roadside, and the stone is now quarried and burnt by the same parties, and yields a very fair lime. About eight feet of it is in sight. Though this stratum underlies nearly all of this township, it is exposed in very few places, and sometimes no trace of it can be discovered. A coal seam is said to occur immediately beneath it, but is too thin to be mined. This is the Scrubgrass Coal bed, which is quite a persistent bed in all of the surrounding county, being found at Clintonville and Mechanicsville, in Venango county, and on Wolf Creek in both Butler and Mercer counties, and on Slippery Rock Creek, in Butler and Lawrence counties, but is never thick enough for profitable mining. A short distance north of the county line, on the Pittsburgh Pike, the limestone outcrops along the roadside,

and has been quarried and burnt for several years by Mr. Baker. Only two or three feet of the upper part of the bed is now visible. It here shows its usual irregularly regular lines of stratification

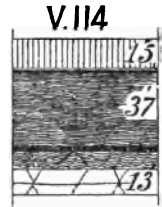
The Kittanning Middle Coal bed is caught in a small round top above the quarry, and was opened and mined some years ago, but the bank has fallen shut, and no examination of the bed was possible.

As the rocks underlying the Ferriferous Limestone are not well exposed within the township, the following section, made on Wolf Creek, near Courtenay's Mills, in Mercer county, is given to show their general character.

The section is really a compound one, embracing the data of two sections, one made at the mills, and one at the limestone quarry, half a mile south from the mills. It is illustrated by Fig. 114:

Section at Courtenay's mills.

Ferriferous Limestone, (61	}	12' to 15'
feet above creek level at the quarry,)		
Shale,		1'
Scrubgrass Coal bed,		1'
Blue slate,		37'
Clarion Coal, (Pardoe,)		2' 3"
Slaty Shale,		9'
Homewood Sandstone, hard and mas-		
sive to creek bed,		13'



The Homewood Sandstone here occupies the horizon of the Brookville Coal bed.

At the limestone quarry below the mills, the Clarion Coal measures 2' 11" and lies only one or two feet above water level, the Homewood Sandstone having disappeared beneath water level with a dip of 20 feet in half a mile.

This coal is the same with the "big bed" at Pardoe on the Shenango and Allegheny R. R. Mr. White states that at the latter place, the Brookville bed is present as a small seam, lying between the "big bed" and the Homewood Sandstone, which there occupies a lower horizon than at Courtenay's mills.

No outcrop of the Ferriferous Limestone can be found between Harrisville and Courtenay's; it may possibly be absent over a part of that area. Near the coal banks owned by Mr. Alex. Brown, several sink holes are noticeable which may indicate the horizon of this stratum. In the railroad cutting near the road crossing, a thin seam of coal from 7" to 12" thick is laid bare, at about the horizon at which we would look for the limestone, but no trace of it is there visible. This coal may be the Scrubgrass bed. It is overlaid by five feet of slate above which three feet of sandstone is exposed.

§ 72. *Marion Township.*

This lies east of Mercer and north of Cherry townships. Its surface is diversified by north and south valleys of tributaries to the North Branch of Slippery Rock creek. The summit lands are often quite fertile, but have been exhausted by overworking and need a thorough recuperative treatment.

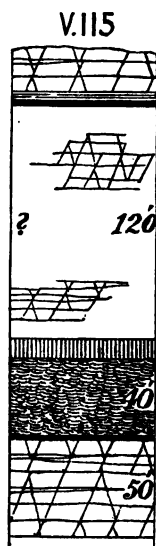
The Freeport Sandstone is caught in the highest hills, and along the low lands of the Slippery Rock branches the Homewood Sandstone is generally in sight, jutting out in broken escarpments on both sides of the stream. The former rock is seldom a massive or prominent stratum, but the latter is always quite hard and generally rather coarse grained.

Section south of Murrinsville.

SS. and shale in summits, (Freeport

Lower SS.)

Kittanning Upper coal, (cannel,) . .	2' to 3'
Shale and SS., partly concealed, . .	120'
Ferriferous Limestone, "say" . . .	10'
Sandy shale,	40'
Coal, (Brookville or Clarion,) . . .	2' to 3'
Concealed—contains hard } massive Homewood SS., }	50'



The Kittanning Group is represented only by the Kittanning Upper bed which is present as a cannel coal, resembling very much the same bed at North Washington. The other beds of this group are either quite thin or absent, and have eluded observation.

On the road from Murrinsville to Annandale the section shown in Fig. 115 was compiled. It extends from the Freeport down to the Homewood Sandstone.

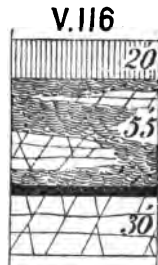
The cannel coal noted in the upper part of this section is the bed mined near Murrinsville, and as nearly all the banks upon it are situated in Venango township, the detailed description of the bed is given in connection with the geology of that township.

The Ferriferous Limestone is seen *in situ* on the road bed, and forty feet below it is the sinut of a coal which may be either the Clarion or Brookville bed. The limestone also outcrops on the road at several places in the southwestern part of the township. On the farm of Mr. Black, about three fourths of a mile north of McMurry's mills, it is finely exposed in an abrupt escarpment and "Rock City." Large blocks from twelve to fifteen feet in height, and from ten to twenty feet square cover the ground below the outcrop, giving it, when viewed from a distance, a striking resemblance to the "Rock Cities" of sandstone and conglomerate so common in the northern counties. It here shows its characteristic withered appearance, caused by the weathering of its wavy lines of stratification. An accurate measurement of the bed could not be obtained, but it can be little less than twenty feet thick.

The exposures seen in this vicinity give the section shown by Fig. 116.

Section on McMurry's Run.

Ferriferous Limestone,	20'
Sandstone and shale,	55'
Brookville Coal,	3' to 5'
Homeward Sandstone,	30'±



The Brookville coal bed has been opened and worked at several banks near the Mercer township line, but most of them have been abandoned, and are now inaccessible. It

is usually of medium or poor quality, always containing much slate, and generally is troubled with many bands of pyrites, is usually quite soft, and mines in small pieces.

It is opened and has been worked quite largely by Mr. R. L. Black, but at present the bank is lying idle, though Mr. Black says that he will shortly again resume mining. The bed was measured in an opening owned by Mr. Ray, where it exhibits the structure shown by Fig.

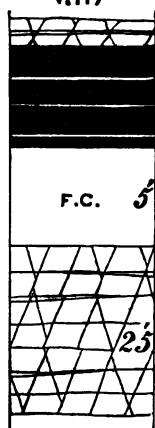
117.

Ray's Coal Bank.

Sandstone roof.

Coal,	1' 6"	}	3"	}	5' 1"					
Slate,	1"									
Coal,	1"									
Slate,	1"									
Coal,	1' 2"	}	1"							
Slate,	1"									
Coal,	1' 5"									
Slaty coal,	2"									
Coal,	6"									
Fireclay floor,	5'									
Homewood Sandstone,	25'±									

V.117



The Homewood Sandstone lies just below the bank, and is finely exposed on both sides of the run, which flows at its base in a small narrow canyon, between nearly vertical walls of this rock, which is here a coarse, massive, and iron-stained sandstone, containing little cementing matter.

§ 73. *Oil and Gas Wells.*

At McMurry's Mill a well was drilled in 1877 by Messrs. Emerson and Bronson and struck a heavy flow of gas, but found no oil. When first struck the flow of gas was very strong, and it is said that after the casing was drawn from the well, the water was thrown, in an almost continuous stream, thirty or forty feet above the top of the derrick. Subsequently it greatly diminished and at present the water is only thrown to a height of thirty-five or forty feet above the derrick floor. This rapid diminution in the volume

and pressure of the gas is probably partly due to the effect of water on the gas rock.

Murrinsville and the country lying west of it, have been the scene of a most diligent search by Phillip Brothers for a southward extension, on their twenty-two degree line, of the Bullion and Clintonville oil field. The country has been punched full of holes, but all as yet to no purpose other than proving that some portions of this area are undoubtedly unproductive.

In many of the wells the Third Sand is said to have been found, but always as a very close and "shelly" rock. No complete records of any of them have been preserved, and the only information that can be obtained of the drillings, is that the general stratification was similar to that found at Clintonville. Most of these dry holes will be found marked on the map by a small circle crossed by two lines.

§ 74. *Venango Township.*

This township, lying east of Marion and north of Washington township, is principally occupied by the high land of the great dividing ridge.

The Ferriferous Limestone is the lowest stratum laid bare within its limits, except in Slippery Rock valley, where the Clarion group is exposed.

The Freeport Lower Coal bed is caught in the summits near the eastern border of the township, and is frequently seen outcropping on the road sides, but is quite thin and little worked.

At the bank owned by Mr. Hughes, one mile southwest from Farmington, it varies from 2' 6" to 3' 0" in thickness but yields a very poor coal. It is opened and worked near Farmington, but is so slaty that it can be used only with difficulty, and produces an immense amount of ash. The bed here measures twenty-eight inches.

Though the Freeport Upper Sandstone is a rather shaly rock, it is generally more prominent than the Freeport Lower Sandstone. It is caught in some of the highest hills, but the overlying limestone and coal are not found.

§ 75. Kittanning Upper Coal, (Venango T.)

This is opened and mined quite extensively at several banks in the vicinity of Murrinsville, where it is from two to two and a half feet thick. The principal openings now in running order are owned by Mr. Gormley, Mr. O'Donnell, Mr. Joseph Murrin, and Mr. Hugh Murrin.

The measurement shown by Fig. 118 was made at the mine owned by the last named gentleman.

Murrin's Cannel Coal Bank.

Slate roof.

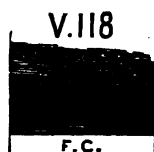
Bone and slate, 1' 0"

Slaty Cannel Coal, 5"

Cannel Coal, 2' 0"

Slate, 3" to 7"

Hard fireclay floor.



The coal is of good quality, resembling very much the North Washington cannel coal; contains but little sulphur, and leaves only a moderate amount of ash.

It is as yet only proven to be a good bed over an area of less than one square mile, and will probably prove to be just such another local development as that at North Washington.

In some localities the Freeport Sandstone forms its roof, but the bed is usually separated from it by a layer of slate from two to ten feet thick.

The section shown by Fig. 119 was compiled from exposures near Murrinsville:

Murrinsville Section.

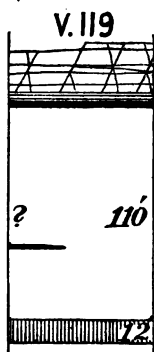
Freeport Sandstone.

Slate, 5'

Kittanning Upper (cannel) Coal, 2' 6"

Concealed: Containing blossom of }
Kitt. Lower Coal near bottom, . } 110' ±

Ferriferous Limestone about, 12'



The interval from the cannel coal down to the Ferriferous Limestone is rather small, but it shows that the former is undoubtedly the Upper Kittanning bed. The limestone is exposed in the hollow west of town, but an accurate measurement of its thickness could not be obtained.

In the valley of Little Scrubgrass Creek, one mile and a half north of Farmington, a bank is opened on a coal which is either the Brookville or Clarion bed. A heavy rain storm had completely closed its mouth by loosening the roof which had fallen in, a few hours before I visited it, and I was unable to make any measurement of the bed.

The Brookville Coal is opened in two banks on the James Higgins farm in the southern part of the township, where the bed exhibits the structure shown by Figs. 120 and 121.

Higgin's Coal Bank, No. 1.

Shale and Sandstone roof.

Draw Slate,	4" to 6"
Coal,	1' 1"
Slate,	$\frac{1}{2}$ " to 1"
Coal,	1' 2"
Slate,	$\frac{1}{2}$ " to 1"
Coal (reported),	2' 0"

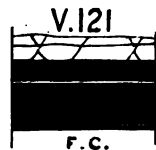
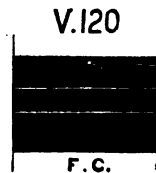
Fireclay floor.

Bank No. 2.

Sandstone roof.

Coal,	1' 10"
Slate,	1"
Coal,	2' 2"
Slaty Coal,	3"

Fireclay floor.



Bank No. 1 is near the road side and at water level. The lower bench was partly hidden, and its thickness is given from the report of men who had worked in the bank. The upper benches yield a fair coal but the lower bench is quite pyritous.

In a well drilled for oil in close proximity to Bank No. 2, and about level with it, the Ferriferous Limestone is said to have been reached at a depth of forty feet. If this report be true, then these coal banks are on the Kittanning Lower bed; but the character of the coal, its tide-water elevation, and the character of the overlying strata, have led me to believe most positively that it is the Brookville bed. No limestone has been found above it, but what is supposed to be the "limestone ore," has been dug from

the hills at several places, at a height of about forty feet above the coal.

The above mentioned well is owned by Mr. Prentice, and was drilled to a depth of about 1,600 feet without finding oil in paying quantities.

From the Higgins Banks southward for about three fourths of a mile, the coal is opened at short intervals by banks in good running order. It shows about the same thickness and quality in all of them.

A sharp, but local, south dip pervades the measures in this locality, and is very prominently shown by the banks on this bed, each of which can, by the eye, be seen to be much lower than the one lying north of it.

The sections given by Mr. Burnett, shown in Figs. 94 and 95, and described in connection with Washington township, will elucidate any unexplained features in the stratigraphy of the southern part of this township.

§ 76. *Allegheny Township.*

This lies in the northern corner of the county, with Venango county on its northern and Allegheny county on its eastern line.

Its central and southern portions are occupied by very high land, but the surface falls off quite rapidly towards Bear creek on the south, the Allegheny river on the northeast, and Little Scrubgrass creek on the northwest.

It is fairly off for coal, but contains no very valuable seams—those of good quality are thin, and the thick ones are generally of ordinary or bad quality.

The Freeport Upper coal is found in local patches in some of the higher lands of the dividing ridge between Bear creek and the Allegheny. It has so little cover that it can never be profitably mined. It lies from 1,500 to 1,530 feet above ocean level, and varies from four to six feet in thickness, but is sometimes so thin that no trace of it can be found, and is possibly absent over large areas. On the ridge road, from Lawrenceburg to Six Points, its smut is frequently seen.

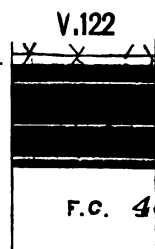
The Hitchcock Slope, one mile southwest from Six Points, is opened on either the Kittanning Middle or Lower bed. The coal is of good quality, but is quite thin, never measuring more than thirty inches, and contains a band of slate near the middle of the bed from one half to two inches thick.

In the same vicinity the Brookville Coal is opened and worked at Mr. Blymiller's Bank, where it shows the structure represented in Fig. 122.

Blymiller Coal Bank.

Sandstone and shale roof.

Coal,	8" to 1' 0"
Slate,	1" to 2"
Coal,	1' 11"
Pyrite band,	2"
Coal,	1' 6"
Fireclay,	2" to 3"
Coal,	3" to 4"
Fireclay (seen)	4' 0"



The lower (1' 6") bench is quite pyritous, but the middle bench yields good coal.

Two other banks are opened in the same bed close to the Blymiller Bank. They are owned by Mr. Davis and Mr. Campbell.

From fifteen to twenty feet above this coal, a bed has frequently been found that is not opened in this neighborhood. It is about two feet thick and is evidently the Clarion Coal bed.

The Brookville bed is also opened at a bank owned by Mr. John Chambers, in a hollow two miles east of Six Points. It yields a medium to fair coal, but is not persistent in thickness. On the opposite side of the run, an entry was driven in upon it for quite a distance but no workable coal was found. A measurement at the Chambers' Bank gave the thickness shown by Fig. 123.

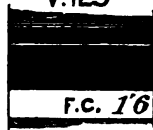
No trace of the Ferriferous Limestone could be found near this bank. It is probably very thin or altogether absent.

Chambers' Coal Bank.

Slaty shale roof.

Draw slate.	4"
Coal,	8"
Slate,	1"
Coal,	2' 3"
Fireclay,	1' to 2' 0"
Slate.	

V.123



Seven or eight years ago an oil well was drilled in this hollow, but though a good show was obtained, it failed to produce oil in paying quantities.

§ 77. The Six Points or Crawford's Corners Oil Field.

This development lies in the northern part of the township, and extends east by north, in a narrow line, a distance of about one and a half miles. Quite a large number of wells have been completed, and these at present aggregate a very respectable production.

The oil is obtained at three different horizons and is of two different grades. That from the "Fifty foot rock" is lighter in color and heavier in gravity than that pumped from the "Stray" and "Third" Sands. The former is of about 42° gravity, but the latter is from 42° to 45° grav., is of a green color, and shows a beautiful wine color by transmitted light. It congeals very rapidly, and great difficulty is experienced by the pipe line engineers in pumping it during cold weather.

The description illustrated by Fig. 124, is a very nearly correct section of the measures penetrated by these wells:

Top of Ferr. Lime. to top of "3d Sand," . .	1205 to 1210'
Top of "1st Sand" to base of "3d Sand," . .	313'
Top of "1st Sand" to top of "50' rock," . .	(156?) 146'
Top of "50' rock to base of "3d SS," . . .	(157?) 167'

About 350 to 400 feet of sandy measures, belonging to the "Mountain Sand" group (Conglomerate Series, No. XII) is found: the "Mountain Sand" being 200 feet thick, with *no shaly or slaty partings*. Twenty-five feet beneath

it is a loose-grained, salt water rock, from fifteen to twenty-five feet thick.

Near the middle of the interval from this rock down to the "First Sand," a shelly sand or a band of shells is frequently struck. This is probably the "3d Mountain Sand" of the Oil Creek region.

78. *The Oil Sand Group.*

The First Sand.

This is composed of ten feet of good white sand, beneath which is an alternation of slate, shale, shells, and grey sandstone to the base of the rock. Near the bottom of the series, a good loose sand is occasionally passed through, and is designated by the name: "30 foot rock." Total thickness of group, . . . 100 ft.

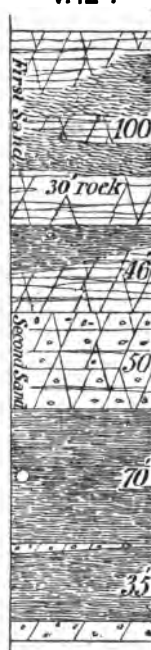
The Forty Foot Red Rock consists of an alternation of slate and shale, with a few intercalated sandy bands. The red rock usually found in the lower part of this interval, is sometimes forty feet thick, and is nearly always quite soft. Thickness of interval, . . . 46 ft.

The Fifty Foot Rock is a good, coarse, pebbly, white sandstone, and probably corresponds to the Oil Creek Second sand. It produces, in small quantities, an oil similar to the typical Second Sand oil, and in some of the wells the yield from this horizon has been as high as four or five barrels per day. It is the gas rock of the district, yielding in nearly all of the wells, sufficient gas to fire the boiler. At some of them it is used directly in the engine cylinder as the motive power. The thickness of this stratum is about, . . . 50 ft.

Interval of soft rock, shale or slate, . . . 70 ft.

(I am inclined to think that this interval should be de-

V.124



creased ten feet, and the surplus added to the space between the First Sand and 50 foot rock.)

"Stray" or Brown Sand. This is a soft, loose, and rather friable, porous, reddish-brown sandstone, entirely different from any sand occurring within the limits of the Venango Oil Sand group. Oil has been found in it by several wells, and some are now producing from this horizon. Its oil is indistinguishable from the "Third Sand" oil of this district. Thickness from, 2 to 6 ft.

Interval of soft measures, 35 ft.

The "Third" Sand is the principal oil rock of the district. It somewhat resembles the "Stray" sand, is quite dark in color, rather fine grained, but porous and friable.

Thickness, 10 to 12 ft.

Though this rock lies at just the right distance below the Ferriferous Limestone (at which many of the wells commence drilling) to be the Oil Creek or Butler Third Sand, it is a rock of totally foreign aspect when compared with sand pumpings from any part of the Venango or Butler Oil Fields, resembling very much a dark Chemung sandstone. I am inclined to think that both the "Stray" and "Third Sand" do not properly belong to the Venango group, but are sands occupying a high place in the Chemung floor on which the latter rests.

If this view be correct, there can be no connection, in this direction at least, between the Clintonville oil sand and the oil rock of Columbia Hill and Parker.

CHAPTER X.

§ 79. *On the Ferriferous Limestone.*

This limestone has its area of best development in Clarion, Armstrong, Butler, Venango, Lawrence and Beaver counties, where it has an average thickness of from 12 to 15 feet, with an occasional local size of from 20 to 25 feet.

Its most northerly outcrop is found in the Johnsonburg coal field, near Wilcox in McKean county, where it is quite thick, and retains its usual lithological characteristics.

It is not found in Clinton county, nor in any part of the State northeast from the Sinnemahoning, but at Karthaus in the northeastern corner of Clearfield county, there is a thin bed of limestone which seems to lie in or near the horizon of the Ferriferous. It may, however, be the northeastern representative of the Johnstown Cement bed, which occupies a place in the measures from 110 to 130 feet above this horizon.* By the First Survey it was supposed to be the Upper Freeport Limestone.

The Ferriferous has no existence in the southeastern subdivision of the First Coal Basin, and need never be looked for in any part of Somerset or the southern half of Cambria county, for Mr. Platt has proven that over this area it is absent, and its place supplied by the Johnstown Cement Bed. It is shown under Pittsburgh in the record and by the sand pumpings of the Boyd's Hill gas well (see Report I.I.I) and is also found by many oil wells in southern Butler. We can therefore assign no limits to its extension south and southwest from the Butler County Oil Field.

Throughout Jefferson, Indiana, Clarion, Armstrong,

* See Report HHH.

southern Venango, Butler, southern Mercer, Lawrence and northern Beaver counties, it is a well marked and easily recognized horizon, and is our best "key-rock" in studying the geology of any part of this area.

In the southern part of Forest county it is caught in a few isolated hilltops just north of the Clarion River, but in Clarion county it is contained in nearly all of the high land.

Its most northern outcrop in Venango county is seen near Tippery corners, six miles east by south from Oil City, where it is from seven to eight feet thick and quite fossiliferous. In southern Venango and southeastern Mercer it is preserved in all of the hills that are high enough to contain it.

In Ohio,—except at Lowellville, on the Mahoning, where it exhibits its usual character,—it is much thinner than in Pennsylvania, and, compared to its value in the latter State, is worth but little, either as a limestone or as an iron-ore carrier. Its outcrop enters Ohio near the Mahoning river.

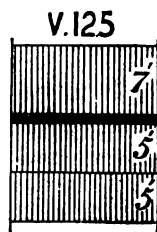
East of the Allegheny, its thickness seldom exceeds six feet, though in some parts of Clarion county it measures ten or twelve feet. Along Red Bank Creek it ranges from four to six feet.

§ 80. *Local Variations in its thickness.*

At Vanporte, in Beaver county, Mr. White obtained the section represented in Fig. 125.

Vanporte Section.

Grey limestone,	7'
Shale,	1'
Grey limestone,	5'
Blue limestone,	5'



The shaly parting here noted is seen in many localities and is sometimes accompanied by a very thin seam of coal.

In the same neighborhood, Mr. White states that the whole stratum suddenly thins down to six inches and is replaced by a bed of shale. If it were replaced by sandstone

we might reasonably suppose that this diminution in size was the result of a subaqueous erosion.*

A precisely similar feature is observed on the Beaver River between Clinton and Wampum. At the latter place the bed measures twenty-two feet, while at Clinton only a few inches of it can be found, but on the east side of the river, directly opposite Clinton, it is again seen in good development with an average thickness of from twelve to fifteen feet.

At Brady's Bend a striking instance of this kind is detected. On the west side of Whisky Run it is a massive stratum, fully fifteen feet thick, but in the hill between the Run and the Allegheny River, it is so thin that no trace of it can be detected. In a well on the Ralph tract, it is said to measure only "half a screw," (two feet.)

It is positively asserted to be absent from oil wells on the Humes Farm, in Clearfield township (Butler Co.), but on Buffalo Creek, three miles east from the wells, it is quite a prominent stratum.

These instances of sudden local variations will explain why it is so often unnoticed in the detailed sections prepared from surface outcrops, for if the bed is subject to such radical changes, we may not be surprised to frequently find it absent, or if not absent, at least so thin that its presence cannot be detected. Such is undoubtedly the case at many localities in Northern Butler, and it must not, therefore, be expected that at every point along the outcrop line shown on the contoured map, this stratum will unfailingly be found.

* Though we can no longer advance the theory of extensive subaqueous erosions by sea currents, (that hypothesis being abandoned because it is impossible to conceive of a current *eroding* while it is constantly and universally *depositing*,) and must utterly deny the possibility of such denudations as *true frictional erosions*, in sandy or muddy deposits, it does not seem improbable that subaqueous erosions of limestone *by solution* may have often occurred.

Our data are insufficient for a discussion of this problem, and we can only hypothetically suggest that new ocean currents, with deeper or shallower water, changing both the temperature and pressure, and bringing with them waters chemically differing from those that filled the basin during the deposition of the limestone, may have effected an erosion by a solvent action upon the then soft limestone.

Whether these irregularities were produced by the original accidents of deposition, or by a subsequent subaqueous erosion is as yet quite uncertain. The overlying measures are sometimes quite soft, but generally are rather sandy shales which might readily have been deposited by an eroding current, but if this were the cause, why is it that we so frequently find the bed so thin, but still persistent as a thin bed? If *fourteen* feet of it was eroded, why should *one* foot be left? These queries might be answered by supposing that where we find the bed persistent as a very thin stratum, it is present only as a secondary product of segregation from the overlying and underlying calcareous strata. This view is supported by the almost universal occurrence of the "*cone-in-cone*" structure where the bed is thin.

In many localities it furnishes an excellent furnace flux, showing by analysis from 90 to 95 per cent. of calcic carbonate, and from 2 to 6 per cent. of silica, with little phosphorus or sulphur.

It is emphatically the best limestone of the Lower Productive coal measures for both agricultural and building purposes, but its value as a fertilizer is not appreciated by the farmers. Its use on the worked out soils of Northern Butler, and of all the Western counties, cannot be too strongly recommended.

When of good quality it burns readily, yielding sometimes a very white lime but generally lime of a light grey color, slacking rapidly and thoroughly.

As a mortar lime, it is found to set in a reasonable time, forming a good, firm, and adhesive mortar, and resists in a fair manner, the disintegrating action of rain and frost.

§ 81. *The Buhrstone Iron Ore.*

In years past immense quantities of iron have been made from the ore bed which usually rests upon this rock, but in many localities all the ore within "striking distance" has been exhausted, and the furnaces blown out. To attempt to run a large stack upon the outcrop ore from this bed is

conceded to be useless by those who have tried it, and drifting upon it will not pay except at localities where it is of unusual thickness.

The ore usually lies in plates or nodular masses, immediately on top the limestone, but sometimes the upper layers of this rock are so ferruginous as to become a calcareous ore, and again the ore is found disseminated in nodules and plates through several feet of shale overlying the former. It sometimes entirely replaces the limestone, forming an immense bed, but such instances are rare. Mr. White describes (Chap. V, Report QQ) a very remarkable occurrence of this kind, where the resulting ore bed is twenty-two feet thick.

The ore balls or nodules which are evidently of concretionary origin, are at times hollow, and the cavity is described by Prof. Rogers as being sometimes filled with "a dark unctuous fluid," but it is usually dry and coated on the inside with a glossy dark blackish coating, with a velvet-like lustre, and is occasionally incrustated with minute crystals of a yellow, blue or purple tinge.

When they are solid, a grain of sand or some foreign material is generally found at the center, forming a nucleus around which the segregation has taken place. Prof. Lesley describes a specimen in which he found a perfect cube of galena, nearly three fourths of an inch in diameter in the core of one of these nodules.

The outside shell is generally a dark and hard peroxidized layer covering the mass of yellowish ore which forms the body of the concretion.

When it occurs in plates it is often of a cherty nature,—hence called the Buhrstone ore,—is greyish to light blue in color, often resembling a ferruginous limestone.

§ 82. *Lithology of the Ferriferous Limestone.*

This rock seldom forms any bold natural escarpments; but where such occur, its weathered outcrop presents a rugged irregular face, seamed by horizontal undulating.

lines of stratification, and is broken at intervals by vertical cleavage fissures and numerous cave mouths.

When lying near the surface, its presence is shown by many "sink-holes" and by the very irregular surface overlying it and kept quite dry by the drainage of numerous subterranean water courses that ramify it in all directions.

Its upper layers are of a dirty grey color, but the lower part is nearly always bluish grey or light blue in color and more impure than the former. On the Beaver River these sub-divisions are very persistent and constant in character. (See Report QQ and Part II.)

All the bed plates and planes of lamination are very irregularly undulating, and present a knobby or knotted appearance. The elevations on one plate fit loosely into corresponding depressions in the overlying layer, but the union between them is not good, and the stone can generally be parted along any of its lines of stratification with little trouble. These layers usually measure from one half to two and a half inches, but sometimes are much thicker.

One of the most striking peculiarities of this rock is the appearance of its outcrop in a road bed. The stone being bruised by passing wagons, and by horse shoes, exhibits a prominent bluish white color, which immediately catches the eye, and is so noticeable that it can frequently be recognized at a distance of half a mile. No other rock in the Lower Productive coal measures ever produces anything similar to the appearance of such an outcrop.

It is a characteristically fossiliferous stratum, and in some localities the rock is wholly composed of fossils in a fair state of preservation, and these are at times beautifully displayed in *bas relief* upon weathered surfaces of the stone. Crinoid stems are especially numerous in it. In Report Q (page 62) Prof. White gives the following as a list of the fossils that he has found in it in Beaver and Armstrong counties :

"*Spirifer Cameratus*.
Spirifer lineatus.
Spirifer opalinus.
Productus Nebrascensis.

Nuculana bellistriata.
Macrocheilus primigenius.
Macrocheilus ventricosus.
Astartella concentrica.

<i>Productus longi spinus.</i>	<i>Polyphemopsis peracuta.</i>
<i>Productus Prattenanus.</i>	<i>Aviculo-pecten carbonarius.</i>
<i>Productus semi-reticularis.</i>	<i>Aviculo-pecten Whiteii.</i>
<i>Hemiphronites crassus.</i>	<i>Athyris subtilita.</i>
<i>Chonetes mesoloba.</i>	<i>Solenomya radiata.</i>
<i>Euomphalus rugosus.</i>	<i>Macrodon obsoletus.</i>
<i>Pleurotomaria Grayvillensis.</i>	<i>Aviculopinna Americana.</i>
<i>Pleurotomaria carbonaria.</i>	<i>Nautilus occidentalis.</i>
<i>Pleurotomaria turbinella.</i>	<i>Platyceras tortum.</i>
<i>Bellerophon carbonarius.</i>	<i>Synocladia biserialis.</i>
<i>Bellerophon Montfortianus.</i>	<i>Lophophyllum proliferum.</i>
<i>Bellerophon percarinatus.</i>	<i>Orthoceras cribrosum.</i>
<i>Bellerophon Stevensanus.</i>	<i>Zeacrinus mucrospinus, and numerous</i>
<i>Nucula ventricosa.</i>	<i>fragments of crinoids.</i>

The Freeport Upper Limestone lies from 225 to 235 feet above the Ferriferous but is a very different rock. It is light gray in color with a rather variegated face when newly fractured, is from one to five feet thick, and always lies *above* the greater part of its associate iron ore. At its outcrop it seldom shows more than a mass of water-worn boulders,—sometimes nodules,—which are often covered with a yellowish argillaceous, and at times ferruginous, layer from $\frac{1}{8}$ to 1 inch thick. No fossils have been found in it except a few very small fresh water shells.

The Freeport Lower Limestone is not so persistent as the Upper bed, except over certain areas where it appears to be quite constant. It is more ferruginous and earthy than the Upper bed and generally not more than one or two feet thick, often consisting of what at first sight appears to be a succession of concretionary nodular masses of very ferruginous character. It is non-fossiliferous and is sometimes entirely replaced by iron ore

In Chapter I of Part II will be found a description of the two Mercer Limestones (Mahoning and Mercer of QQ). They need never be mistaken for the Ferriferous.

In conclusion we may state that there is no similarity whatever between the Ferriferous Limestone and any other bed found in the Lower Productive Coal Measures. They are all more impure, are non-fossiliferous, do not present the withered appearance of the former, and but seldom are exposed in natural outcrops.

We are therefore prepared to advocate to the fullest extent the use of this stratum as a “key-rock” to the forma-

tions both above and beneath it, and have so utilized it throughout this report.

The Butler County Third Oil Sand is found at from 1160 to 1200 feet beneath the top of the Ferriferous and the Fourth Sand at about 60 feet beneath the Third. The parallelism between two such widely separated rocks is certainly very remarkable, for at Oil City the interval between them is very nearly the same as at Karn's City, the two places being over thirty miles apart.

All of the Butler county oil operators are well acquainted with the regularity in this interval from the Limestone down to the Third Sand, and have been saved many thousands of dollars by it. When the driller is ignorant of the position of the Limestone, with reference to the well mouth, he is uncertain where the oil sand will be found, and it is sometimes pierced unexpectedly, before any preparations have been made for storing the oil, and if a flowing well is struck, it frequently flows upon the ground for nearly two days before any tanks can be erected.

In Chapter IV this limestone is used as a key-rock, and it is there shown that the distance of any coal bed above or below it, will generally determine correctly the name of the coal. The generalization given in that chapter is of course only applicable to the area between the Allegheny and Beaver Rivers, and would require some modification to make it agree with the stratification east or west of this district, and would also require some alteration when applied to the country south of Butler. In the vicinity of Pittsburgh these measures are far beneath water level, but we have obtained some little insight into their character from the records of oil and gas wells (See Report I.I.I).*

*The facts embraced in this chapter, have been obtained, partly from my surveys of Butler County in 1878, of the Beaver and Shenango valleys in 1875 (See Part II) and partly from data collected in the oil regions during my connection with Mr. Carll in 1876-7. Having long felt the need of a comprehensive description of this, the most important stratum of the Lower Productive coal measures, I have prepared this summary of facts, not only to supply such need, but to justify the prominence that I have given to this stratum throughout the report.

CHAPTER XI.

§ 83. *Oil Fields of Butler County.*

The first producing wells in this county were located in the northeast corner of Parker, and southeast corner of Allegheny township in what was then called the Parker Oil District. They were not very large wells, but nearly all of them produced oil in paying quantities and some of the rather better ones averaged a production of from 50 to 150 bbls. per diem for a long period. The territory in that neighborhood has held out quite well, and many of the old wells are still producing enough to make it an object to pump them. Under stimulus from the high price of oil in 1876-7 many wells that had been abandoned during the depression of '74 were cleaned out and pumped, in some instances yielding as high as 5 to 8 barrels per day.

They are all Third Sand wells, and the character of the stratification is here in such conformity with the Venango county drillings, that it is fair to conclude that this sand is truly equivalent or of contemporaneous origin with the Third Sand of Oil Creek and Bullion. No other locality on the Butler-Clarion belt shows such an agreement with the arrangement of the sands on the Venango belt as here exists. The First, Second and Third Sands can all be recognized at their proper horizons in well records from this locality, but at all other places in the county these sands are so split up by shales, slates, and red rocks that it is generally impossible to tell where the First Sand ends and the Second begins, or where the latter ends and the Third begins. The names given to the different members of the group are purely arbitrary and do not express any synchronism between the individual sandstones here, and those on Oil Creek. At the latter place the names "First," "Second" and "Third" were given to three

easily recognized sandrocks occupying a space (vertically) of between 300 and 350 feet. The Second Sand occurs at about the middle of the group. Each sand may roughly be said to average 40 feet in thickness. This type of stratification as shown by Mr. Carll in report I.I.I. has been traced southwest as far as the southern limits of the Bullion Oil Field, and in the prolongation of the same line may be recognized in Butler County as far as Muddy Creek. But the only place on the Butler-Clarion belt at which it is plainly exhibited is at Parker.

In the Butler District the group of sands is found intact, but shows a very different arrangement from the Oil Creek type. In the following summary, which is the drillers' nomenclature, the so-called "First Sand" has been omitted, because it is not the true First Sand, but the "Third Mountain Sand," or Berea Grit. It is separated from the true First Sand (Drillers' "Second Sand") by a thick band of soft shales and slates, containing sometimes the Bedford (Ohio) Red Rock.

Drillers' Nomenclature.

Second Sand.	(Oil Creek "First Sand.")
(Interval.)	
Fifty-foot Rock.	(Oil at Martinsburg, Six Points?, etc.)
(Interval.)	
Thirty-foot Rock.	(Oil at Martinsburg.)
(Interval.)	
Blue Monday.	
(Interval.)	
Boulder.	
(Interval.)	
Stray Third.	(Locally oil bearing.)
(Interval.)	
Third Sand.	(Main oil horizon.)
(Interval.)	
Stray Fourth.	(Locally oil bearing.)
(Interval.)	
Fourth Sand.	(Oil on "Cross-belt.")

Though these sandrocks are all very variable, both in thickness and composition, and are separated by equally in-

constant bands of shale, slate, and red rock, the total thickness of the group is subject to but slight variations, usually ranging from 275 to 325 feet with an occasional thickness of 350 feet. Often several of these rocks are entirely replaced by soft measures, and again, the soft rocks will pinch out, allowing two or more of the sandrocks to coalesce.

The Ferriferous Limestone is used as a "Key rock" throughout the district, the Third Sand being looked for at 1160 to 1200 feet, and the Fourth at 1250 to 1275 feet beneath its top.

The Butler District, like all other oil territory, has been developed spasmodically in local patches. In 1873 some adventurous producers began drilling far ahead of proven territory, in the area now known as the Greece and Modoc District, and were quite unexpectedly rewarded by large wells. The first of these was the Troutman Well at Modoc, which was struck March 23rd, 1873.

The county was immediately swarming with speculators and producers, who started wells in all directions. Some of these were located between Parker and Modoc, some south and west from Modoc, some near Butler and others east of these lines. Shortly after the Troutman Well was struck, good wells were obtained at Petrolia, and in an incredibly short time nearly the whole of the Butler District was in an advanced stage of development.

The location of wells at Greece, Petrolia, and Armstrong Run (Armstrong county) in an apparently lower sand ("Fourth Sand") than the "Third Sand," gave rise to the "Cross belt" theory, and in 1874 this belt was pretty thoroughly developed. It yielded very large wells, some of which produced over 3000 barrels a day when first struck, but they all declined very rapidly and soon the best of them were moderate sized "pumpers."

Meanwhile developments had been progressing at the southern end of the Third Sand Belt, and the territory around St. Joe had been opened up, and in 1875-6 the Carbon Centre district was reached.

Most of the territory between Petrolia and Parker was at first neglected, and it was not until the areas surrounding

Parker, Karns City, and Millerstown had been pretty well perforated, that this portion of the district was operated upon.

In 1876 and 1877 several new productive patches were discovered northwest and southwest of Martinsburg, and west of Parker. These obtained their oil from the "Thirty-foot Rock," though some of them have produced from the Third Sand, and some have found small quantities in the "Fifty-foot Rock."

In 1877 the Millerstown Eastern Belt and the Kaylor district were discovered, and a new pool was found at the mouth of Whiskey Run, in Armstrong county. These found their oil in the Fourth Sand.

The production of these additional areas has been entirely too small to compensate for the failing production of the older wells, so that the pipe line runs for 1876-7-8 show a great falling away from the amount produced in 1874-5.

The "wild-catting" * that has been done all over the county, has thus far failed to discover any productive territory west of the so-called Third and Fourth Sand belts. At Hermon Station, on the Butler Branch R. R., and also at the Humes Farm, $\frac{1}{2}$ mile east of Jeffersonville, in Clearfield township, a small area has been found over which Fourth Sand wells of medium size are obtained, but these patches lie so far south that the sand is only reached after drilling to a depth of from 1600 to 1800 feet, and can only be profitably operated upon in times of high priced oil.

Near Six Points in Allegheny township, there is a very fair local development in a sand which probably belongs to a lower series of rocks (geologically) than the oil sands of the Third Sand Belt. A full description of their drillings is given in the report on Allegheny township. If, as I have there stated, the Six Points oil rock is Chemung, it follows that we may never expect to find a connection between the Bullion and Parker oil sands, and we must consider them as two independent ranges of rock of the same age.

Two miles northwest from North Washington are the

* Drilling wells in "wild cat" or undeveloped territory.

Rumbaugh oil wells. Three or four wells have been drilled there, and two have yielded oil in paying quantities from a sand which lies at the proper depth beneath the Ferriferous Limestone, to be either the Butler Third or Fourth Sand. A detailed description of these wells will be found in Chapter IX. It is possible that the rock there found may be an outlier from the southward prolongation of the Venango-Bullion Oil Sand.

Phillips Brothers, the large Bullion operators, as well as H. L. Taylor, Nesbitt, and other prominent producers, have spent much time and money searching after an extension of this (Bullion) belt in the western part of the county. The facts brought out by the John Smith, Rumbaugh, Wolf Creek, Slippery Rock Creek, and other oil well records, make it appear more than probable that the Venango Group of sandrocks does have a fair development in that part of the county.

At Raymilton, in Venango county, eight miles northwest of the Venango oil belt, the structure shown by all the wells may be stated thus:

Red rock, thick, 100'

First Oil Sand, 20'

Interval—no Second Sand.

Third Oil Sand—grey and poor.

The Wolf Creek well record may be generalized in a similar manner:

Red rock, 80'

First Oil Sand, 11'

Interval—no Second Sand.

Third (?) Oil Sand—grey; oil show in "stray."

This is an almost exact agreement in structure, and it is but reasonable to conclude that at the Wolf Creek well we are oriented in the same position with respect to the Venango belt, as at Raymilton. The Venango Group of sandrocks therefore should be looked for in the country east of Wolf creek.

The record of the John Smith well, near Muddy creek, exhibits a stratification agreeing in every particular with that of the Venango-Bullion type, and it is quite probable

that this well is located within the locus of that group. It also seems probable, from the above deduction, that the Rumbaugh wells are on the pebbly edges of the Oil Creek Third Sand. For a fuller discussion of these facts, the reader is referred to Mr. Carll's Report.

The existence of this group of oil rocks does not unfailingly insure the presence of oil in paying quantities, nor does it, if productive, denote the existence of any large area of paying territory. On the contrary, all the facts in our possession indicate that if this region ever proves productive, it will be in isolated pools or patches, and not continuous as such for any great distance.

The connection from Clintonville southward seems to be effectually broken by the great number of dry holes obtained at Murrinsville, (see Marion township,) and wells at Annandale, and on both the north and south branches of Slippery Rock creek, together with others in Cherry, Clay, and Franklin townships, besides three on Muddy creek, prove that if these measures do exist, they can only be productive in narrow "streaks" or small pools; but there is still room left for several local developments, such as the Bullion district.

In the present depressed condition of the oil business, with the heavy stocks on hand, and the large production of the Bradford oil field, it is to be sincerely hoped that no such tracts will be discovered.

Since the birth of the "Cross belt" theory constant efforts have been made to find some extension of its productive area southwest from Greece City, but they have hitherto proven futile, and it seems to be pretty clearly demonstrated that there are no undeveloped tracts remaining in that vicinity.

§ 54. *Theory of "Bell Lines."*

The Butler County Oil District has been the means of converting hundreds of producers to an unreasoning, dogmatic belief in this theory, which is generally accepted, is that the productive or pebbly streaks of the oil sand run in

unvarying straight lines that can be traced as such by means of compass or transit lines, for several miles ; and wells located accurately on these lines will always prove productive. The fallacy a theory so stated is self evident to anyone familiar with the character of sedimentary rocks, and the agencies by which they were deposited. But *within certain limits*, and when used in a general way, the idea is a good one, and has saved large sums to operators in this district.

If, as Mr. Carll has suggested, these rocks were sea shore deposits, or if they were off-shore current deposits, their pebbly layers would certainly be roughly conformable to that shore, and would constitute a system of sand bars or beaches, of irregular shape, never very wide, but running, within certain limits, in a given direction, subject of course to curves or other departures from a straight line that can now only be determined by the drill. We may then rely in a great measure on the *general trend* of the productive areas when looking for their continuation southwest or northeast, but to depend upon a compass line to trace out *one individual sandy streak* is, as Prof. Lesley has described it, like a boy marking pencil lines on the top board of a wood pile to determine the direction of the grain in the bottom board.

The general trend of the Butler Belt is south 22° west, some operators making use of $22\frac{1}{2}^{\circ}$, and others of 20° north by east.

On the Fourth Sand or Cross-belt, the belt lines used in locating wells vary from N. 45° E. to N. 88° E. the belt showing a decided curve from northeast to southwest.

Within the last two years lines of all imaginable bearings have been run across the country in the vain attempts to trace out the prolongation of locally productive pools. At the time of the Millerstown Eastern Belt excitement lines were run in every direction, northeast, north, northwest, southwest, south and southeast, from the productive streak, showing how reluctant men are to abandon a method they have once successfully used, even after it has been proven to be no longer valuable to them. The following fig-

ures show the elevation above or below ocean level of the top of the Third and Fourth Oil Sand, at the principal towns within the productive limits. The elevations above ocean level are marked +, and those below are marked—.

By means of these elevations, and the tables giving the oil well elevations, the depth of the productive rock beneath the surface, can readily be determined :

§ 85. Oil Sand Elevations.

<i>Locality.</i>	<i>Third Sand.</i>	<i>Fourth Sand.</i>
Columbia Hill,	above ocean, . . . +100'	
Parker,	above ocean, . . . + 60'	
Farrentown,	above ocean, . . . + 10'	
Stone House,	below ocean, . . . — 8'	
Martinsburgh,	below ocean, . . . — 30'	
Fronsinger Farm,	below ocean, . . . — 20'	
Argyle,	below ocean, . . . — 70'	
Petrolia,	below ocean, . . . —100'	
Fairview,	below ocean, . . . — 90'	—175'
Modoc,	below ocean, . . . —120' (?)	—200'
Greece,	below ocean, . . . —220'	—300'
Criswell,	below ocean, . . . —105'	—190'
Brady's Bend, (Furnaces,) . . .	below ocean, . . . —130' (?)	—215'
Karns City,	below ocean, . . . —160'	—250'
Millerstown,	below ocean, . . . —215'	—320'
St. Joe,	below ocean, . . . —260'	—335' (?)
Carbon Centre,	below ocean, . . . —294'	—376'
Hume's Farm,	below ocean, . . . —375' (?)	—457'
Hermon Station,	below ocean, . . . —418' (?)	—500'

These elevations show that the average dip south by west is about 23 feet per mile.

§ 86. Oil Well Elevations.

The subjoined tables of oil well elevations were compiled in 1877 for publication in Mr. Carl's report I.I, partly from Mr. Hatch's field notes, and partly from my own surveys, and a number of detached surveys made by private individuals, reducing them all to the ocean level datum determined by Mr. John H. Carl's releveling of the Allegheny Valley and Butler Branch railroads.*

* For these surveys see Report I.I. chap. XXVI.

The main line of levels from Parker, southwest along the oil belt, checked within four tenths of a foot at Summit and Great Belt stations on the Butler Branch road, showing that there can be but little error in any of the heights determined by it.

In regard to the method by which these elevations were obtained, I quote what Mr. Carll says of them (chap. XXV).

“Our plan has been, in leveling through a closely drilled district, to keep the direct line of levels with a great deal of care, while the numerous side wells are taken more rapidly and with less caution, and the notes used in such a manner as not to affect the integrity of the main line in case an error of a few inches should be made on any particular side well. The variation of a foot, or even more, in the actual levels between two wells is practically of no account in a study of their records, for be the levels to the well mouths ever so precise we are still dependent on the drillers' measurement of the bore hole, where an error is quite likely to occur, for the most important elements in our calculations.

“But while the plan adopted secured good results along the main line, which was found to run through with very gratifying accuracy from Parkers to Great Belt City, it is still open to an opportunity for slight disagreements, which, although really of no importance, may make some of the levels appear to lack that strict consistency and relative agreement which are regarded as the proofs of accurate instrumental work.

“Transverse lines must necessarily be run, and these may be for convenience, or thoughtlessly, based by one party on some one of the secondary wells of another party, and the possibility of error may be augmented, perhaps, by taking the casing head as the level point where the derrick floor was previously used, or *vice versa*. Thus disagreements appear which are not due to instrumental inaccuracies, but to a misunderstanding of hasty or meagre notes.

“Another difficulty encountered by every engineer who has undertaken this kind of work, is to obtain the names of the wells and their locations so that they can at all times thereafter be identified by himself and others. He may

learn that this is Smith well No. 1, farm unknown. It is perhaps the only well in the vicinity at the time, and the name seems definite enough. But a few months later some one attempts to connect his levels with Smith No. 1, and he finds that Mr. Smith has a lease on the Jenkins farm and another adjoining on the Jones farm.

"There is now a Smith No. 1 on each lease, and which is the well referred to no one can tell to a certainty, but the probabilities are he will be directed to the wrong one, and a disagreement of levels is the result. Then, too, the pumpers frequently have one name for a well while the owners have another, and the name is changed as often as the ownership of the well changes.

"But notwithstanding the drawbacks mentioned, the publication of these well elevations cannot but be of great service to a large class of oil operators. They give a general idea of the topography of the country, and afford the means of approximate comparisons of levels both of surface and oil sands to those who are acquainted with the localities and the histories of the wells, which could not be obtained in any other way."

Wells in the Vicinity of Parker.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1205*	J. E. Brown,	Parker City,	Perry, Arm-	879
1206	Clearfield,	Lawrenceburg,	strong Co.,	1096
1207	Maggie,	Farrentown,	do.	1140
1208	Parsons,	do.	do.	1033
1209	Armstead,	do.	do.	1140
1210	Sulphur Water Well,	Thoms Run,	do.	912
1211	Lioness,	Duchess Farm,	Allegheny,	1066
1212	Divide or "Vide," . .	do. do.	Butler Co.,	1104
1213	Forker, No. 1,	do. do.	do.	1097
1214	Critchlow,	do. do.	do.	1097
1215	Marion,	Robinson Farm,	do.	1161
1216	Dull,	do. do.	do.	1174
1217	Clifford,	do. do.	do.	1171
1218	Game,	do. do.	do.	1104
1219	Darling,	do. do.	do.	1102
1220	Well,	Columbia Hill,	do.	1452
1221	Well,	do. do.	do.	1460
1222	Well,	do. do.	do.	1465

* These figures are the running index numbers of Report I.I.

	NAME.	Locality	Township.	Elevation ab. ocean.
1223	Well,	Columbia Hill,	Allegheny,	1471
1224	Well,	do. do.	do.	1464
1225	Columbia, No. 3, . . .	Reddick Farm,	do.	1490
1226	Columbia, No. 2, . . .	do. do.	do.	1479
1227	Hoopskirt, No. 1, . . .	Robinson (?) Farm,	do.	1311
1228	Hoopskirt, No. 4, . . .	do. do.	do.	1379
1229	Tycoon,	do. do.	do.	1332
1230	Booth,	do. do.	do.	1319
1231	Exchange,	do. do.	do.	1235
1232	Mystic,	Robinson or Duchess, . . .	do.	1233
1233	Maple Shade,	do. do.	do.	1290
1234	South Side,	do. do.	do.	1319
1235	Well,	Black Farm,	do.	1223
1236	Well,	do. do.	do.	1182
1237	Well,	do. do.	do.	1184
1238	Well,	do. do.	do.	1171

Wells at Stonehouse.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1239	Ed. Bennett, No. 1, . .	Stonehouse Tract,	Parker,	1015
1240	Ed. Bennett, No. 2, . .	do. do.	do.	1007
1241	Butler, No. 1,	do. do.	do.	1005
1242	Well,	Person's (?) F., N. Bear cr.,	do.	1149

Wells near Martinsburg, Campbell and Argyle.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1243	Hart & Hicks, No. 1, . .	H. H. Say Farm,	Parker,	1289
1244	Hart & Hicks, No. 2, . .	do. do.	do.	1371
1245	Hart & Hicks, No. 3, . .	do. do.	do.	1407
1246	Cornwall, No. 1,	Near Martinsburg,	do.	1319
1247	Jacobs,	Sedgwick Farm,	do.	1156
1248	Billy Patterson,	Fronsunger Farm,	do.	1382
1249	Jenkins,	Say (?) Farm,	do.	1132
1250	Rattling Jack,	do. do.	do.	1183
1251	Brawley, No. 1,	Fletcher Farm,	do.	1127
1252	Arrowsmith,	do. do.	do.	1129
1253	Bennett, No. 1,	do. do.	do.	1138
1254	Wildcat, No. 1,	do. do.	do.	1135
1255	Harrington, No. 1, . . .	Gibson Farm,	do.	1133
1256	Rebecca Jane,	do. do.	do.	1143
1257	Ingleside,	do. do.	do.	1145
1258	Rosebud,	do. do.	Fairview,	11.1
1259	Harrop & Co.,	Harrop Farm,	do.	1149

	NAME.	Locality.	Township.	Elevation ab. ocean.
1260	Emery & Caldwell, No. 1,	R. D. Campbell Farm, . .	Fairview,	1156
1261	Emery & Caldwell, No. 4,	do. do.	do.	1160
1262	Robt. Campbell,	do. do.	do.	1157
1263	Argyle,	A. L. Campbell Farm, . .	do.	1163
1264	Satterfield & Taylor, . .	do. do.	do.	1162
1265	Bly & Rowley, No. 2, . .	do. do.	do.	1171
1266	Good Enough, No. 1, . .	do. do.	do.	1164
1267	Good Enough, No. 2, . .	do. do.	do.	1171
1268	A. L. Campbell, No. 3, . .	do. do.	do.	1171
1269	A. L. Campbell, No. —, . .	do. do.	do.	1168
1270	Lady Campbell, . . . . .	. . . . .	do.	1166

Wells near Petrolia and Karns City.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1271	Shidemantle,	Petrolia,	Fairview,	1171
1272	Lightfoot,	do.	do.	1175
1273	S. N. Delap, No. 1, . . .	do.	do.	1177
1274	Nesbit & Lardin, No. 1, . .	J. Blaney Farm,	do.	1179
1275	Nesbit & Lardin, No. 3, . .	do. do.	do.	1188
1276	Nesbit & Lardin, No. 5, . .	do. do.	do.	1181
1277	Hazlewood Co., No. —, . .	Blaney or Sheakley Farm, . .	do.	1198
1278	Hazlewood Co., No. —, . .	do. do. do.	do.	1176
1279	Ralph,	W. A. Wilson Farm,	do.	1190
1280	Spence,	do. do.	do.	1206
1281	Hazlewood, No. 8,	H. P. Sheakley Farm, . . .	do.	1189
1282	Hazlewood, No. 13,	do. do.	do.	1226
1283	Hazlewood, No. 21,	do. do.	do.	1298
1284	Hazlewood, No. —,	do. do.	do.	1202
1285	Sheakley, No. 1,	do. do.	do.	1214
1286	Say, No. 1,	Mrs. Smith's Farm,	do.	1185
1287	Say, No. 2,	do. do.	do.	1184
1288	Smith & Thompson,	do. do.	do.	1206
1289	Perdue, No. 1,	do. do.	do.	1192
1290	Perdue, No. 2,	do. do.	do.	1191
1291	Preston Water Well,	do. do.	do.	1196
1292	Christian & Cameron,	Hazlewood Oil Co. Tract, . .	do.	1210
1293	McDonald,	do. do. do.	do.	1187
1294	Frothingham, No. 1,	M. Banks Farm,	do.	1198
1295	Banks, No. 1,	do. do.	do.	1196
1296	Banks, No. 2,	do. do.	do.	1197
1297	Mattison & McDonald,	McClyman's Farm,	do.	1244
1298	Rob Roy,	do. do.	do.	1221
1299	McClymans, No. 7,	do. do.	do.	1297
1300	Nesbit & Lardin, No. 2, . .	Jamieson Farm,	do.	1185
1301	Templeton,	do. do.	do.	1222
1302	Banks & Gaily,	W. Scott Farm,	do.	1221
1303	Tack & Morehead, No. 1, . .	McAlear (?) Farm,	do.	1233
1304	Tack & Morehead, No. 2, . .	do. do.	do.	1229

Wells near Petrolia and Fairview.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1305	Jennings, No. 5, . . .	Dougherty Farm,	Fairview,	1217
1306	Reed,	do. do.	do.	1222
1307	Newton,	do. do.	do.	1231
1308	Evans, No. 21,	do. do.	do.	1393
1309	Hornet,	McCleary Farm,	do.	1284
1310	Spider,	do. do.	do.	1264
1311	Dougherty, No. 2, . . .	do. do.	do.	1327
1312	Mitchell, No. 2, . . .	do. do.	do.	1317
1313	Strickland & Fuller, . .	do. do.	do.	1322
1314	Cleminger & Maxwell, .	do. do.	do.	1399
1315	Sutton, No. 4,	P. Sutton Farm,	do.	1436
1316	Mary Ann,	W. Wilson Farm,	do.	1288
1317	Lauretta, No. 1,	do. do.	do.	1254
1318	Lauretta, No. 2,	do. do.	do.	1324
1319	Hope,	do. do.	do.	1269
1320	Shanghal,	do. do.	do.	1306
1321	Anderson,	do. do.	do.	1360
1322	Mayville, No. 2,	Mayville Tract,	do.	1374
1323	Mayville, No. 4?, . . .	do. do.	do.	1331
1324	Patton, No. 2,	Patton Farm,	do.	1369

Wells near Modoc and Greece City.

	Name.	Locality.	Township.	Elevation ab. ocean.
1325	Down East, No. 1, . . .	D. C. Rankin Farm, . . .	Concord,	1246
1326	Down East, No. 2, . . .	do. do.	do.	1220
1327	Dougherty, No. 3, . . .	do. do.	do.	1219
1328	Dougherty, No. 3, . . .	do. do.	do.	1237
1329	Maggie,	Ralston Farm,	do.	1249
1330	Frank,	do. do.	do.	1224
1331	Hare,	J. Starr Farm,	do.	1248
1332	Osceola,	do. do.	do.	1219
1333	Maud Jack,	do. do.	do.	1220
1334	Brawley & Overy, . . .	do. do.	do.	1239
1335	Modoc,	S. Troutman Farm, . . .	do.	1227
1336	Hope, No. 2,	do. do.	do.	1228
1337	Hope, No. 1,	do. do.	do.	1239
1338	High Flyer,	do. do.	do.	1231
1339	Dead Beat,	do. do.	do.	1277
1340	Mohawk,	do. do.	do.	1273
1341	Forest City,	do. do.	do.	1272
1342	Smith,	do. do.	do.	1249
1343	Hooker Jim,	J. Sutton Farm,	do.	1249
1344	Sutton,	do. do.	do.	1261
1345	Darrar,	do. do.	do.	1286
1346	Lady Sutton,	do. do.	do.	1268
1347	Columbia Oil Co., No. 2,	do. do.	do.	1281
1348	Columbia Oil Co., No. 3,	do. do.	do.	1288

	NAME.	Locality.	Township.	Elevation ab. ocean.
1349	Gordon, No. 19, . . .	S. McClelland Farm, . . .	Concord,	1281
1350	Miller Oil Co., No. 1, .	do. do.	do.	1254
1351	Lady McClelland, . .	do. do.	do.	1269
1352	Glade,	do. do.	do.	1253
1353	Hoover,	do. do.	do.	1220
1354	McClelland, No. 1, . .	do. do.	do.	1200
1355	Preston,	W. Brown Farm,	do.	1185
1356	Maggie, No. 1,	G. Barnhart Farm, . . .	do.	1170
1357	Denny,	G. R. Campbell Farm, . .	do.	1164
1358	Gordon,	do. do.	do.	1161
1359	Collins' Bros.,	do. do.	do.	1142
1360	Roberts,	do. do.	do.	1147
1361	Woods & Ripley, No. 1,	D. Barnhart Farm, . . .	do.	1137
1362	Woods & Ripley, No. 2,	do. do.	do.	1137
1363	Big Medicine,	J. C. Brown (heirs) Farm,	do.	1179
1364	Oliver,	Jamieson Farm,	do.	1123
1365	Sadie,	do. do.	do.	1122
1366	Mary Ann,	do. do.	do.	1117
1367	Constable, No. 1, . . .	do. do.	do.	1122
1368	Roberts,	do. do.	do.	1142
1369	Morrison, No. 1,	Morrison Farm,	do.	1110
1370	Morrison, No. 2,	do. do.	do.	1113
1371	Karna,	do. do.	do.	1111
1372	Red Cross,	do. do.	do.	1105
1373	Invincible,	do. do.	do.	1110
1374	Preston, No. 1,	?	do.	1102
1375	Huselton,	Huselton Farm,	do.	1134

Wells east of Petrolia.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1376	School House, No. 1, . .	W. W. McDermott Farm,	Fairview,	1217
1377	McGarvey, No. 1, . . .	McGarvey Farm,	do.	1273
1378	McGarvey, No. —, . . .	do. do.	do.	1225
1379	Forman, No. 3, ? . . .	do. do.	do.	1354
1380	Boyle, No. 1,	do. do.	do.	1354
1381	Boyle, No. 2,	do. do.	do.	1294
1382	Boyle, No. 3,	do. do.	do.	1330
1383	Boyle, No. 4,	do. do.	do.	1350
1384	Morehead & Lardin, No. 2,	Mortimer Farm,	do.	1420
1385	Kerna, No. 6,	Snow Farm,	do.	1464
1386	H. L. T. & Co., No. —	Carner Farm,	do.	1347
1387	H. L. T. & Co., No. 3,	do. do.	do.	1404
1388	— Well,	do. do.	do.	1366
1389	Lone Star, No. 1,	do. do.	do.	1362
1390	Jennings, No. 5,	Steele Farm,	do.	1466
1391	Jennings, No. 4,	do. do.	do.	1462
1392	Boss,	J. Parker Farm,	Perry, Arm- strong Co.,	1279
1393	Cummings, No. 1, . . .	Adam Peters' Farm, . . .		1230

	NAME.	Locality.	Township.	Elevation ab. ocean.
1894	Hunter & Cummings, No. 9,	Crawford Farm,	Perry,	1384
1895	Hunter & Cummings, No. 10,	do. do.	do.	1320
1896	Hunter & Cummings, No. 11,	do. do.	do.	1392
1897	B. B. I. Co., No. 4,	B. Bend Tract,	Brady's B.,	850
1898	B. B. I. Co., No. 5,	do. do.	Armst'g co.,	852
1899	B. B. I. Co., No. 12,	do. do.	do.	972

Wells near Karns City and Millerstown.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1400	Emerson & McCloud, No. 1,	L. Riddle Farm,	Fairview	1249
1401	Emerson & McCloud, No. 2,	do. do.	do.	1244
1402	Grace,	do. do.	do.	1236
1403	Riddle, No. 16,	do. do.	do.	1238
1404	Say, No. 1,	Kincaid Farm,	do.	1240
1405	Say, No. 5,	do. do.	do.	1244
1406	Say, No. 7,	do. do.	do.	1299
1407	Kincaid,	do. do.	do.	1281
1408	Thompson,	A. Ford Farm,	do.	1338
1409	Prentice, No. —,	do. do.	do.	1371
1410	Prentice, No. —,	do. do.	do.	1371
1411	Saulsbury,	J. B. Campbell Farm,	do.	1292
1412	Bott Bros., No. —,	J. P. Campbell Farm,	do.	1374
1413	Angel, No. 6,	J. Moore Farm,	do.	1297
1414	Angel, No. 9,	do. do.	do.	1899
1415	Lady Moore,	W. Moore Farm,	do.	1276
1416	McVey & Co., No. 1,	do. do.	do.	1364
1417	Keystone,	do. do.	do.	1398
1418	Hogan,	B. B. Selbert Farm,	do.	1818
1419	Selbert,	Selbert Farm,	do.	1386
1420	Uncle Hiram,	do. do.	do.	1387
1421	Sheakley, No. 2,	Sheakley ? Farm,	Donegal,	1388
1422	Sheakley, No. —,	do. do.	do.	1186
1423	Wyatt, No. —,	D. Barnhart Farm,	Fairview,	1319
1424	Gordon Bros.,	do. do.	do.	1270
1425	Wyatt, No. —,	do. do.	do.	1276
1426	Marcus Brownson,	do. do.	do.	1808
1427	Bennett,	do. do.	do.	1277
1428	Old Boyer,	do. do.	do.	1259
1429	D. Barnhardt, No. 2,	do. do.	do.	1201
1430	Scudder,	Kepple Farm,	do.	1332
1431	McGill,	Daubenspeck Farm,	do.	1310
1432	McMichael,	P. McDermott Farm,	do.	1342
1433	Cherry Tree,	Hemphill Farm,	Donegal,	1322
1434	J. Barnhart,	Barnhart ? Farm,	do.	1169
1435	F. Barnhart,	do. do.	do.	1194
1436	Preston,	J. Hemphill Farm,	do.	1168

	NAME.	Locality.	Township.	Elevation ab. ocean.
1437	Little Joe,	J. Hemphill Farm, . . .	Donegal,	1164
1438	Shreve, No. 1,	A. Stewart Farm, . . .	do.	1195
1439	Shreve, No. 1,	do. do.	do.	1210
1440	Blue Factory,	Sheakley (heirs) Farm, .	do.	1172
1441	McKinney, No. 2, . . .	Hemphill (heirs) Farm ?,	do.	1163
1442	McKinney, No. 4, . . .	do. do.	do.	1179
1443	McKinney, No. —, . . .	do. do.	do.	1191
1444	Stoughton,	Widow Hemphill Farm, .	do.	1176
1445	Captain Jack,	do. do.	do.	1189
1446	Shite Poke, No. 1, . . .	Frederick Farm,	do.	1172
1447	Warner,	Warner Farm,	do.	1202
1448	McClintock,	Millerstown,	do.	1156
1449	McCullough,	do.	do.	1156
1450	Brown & Kiss,	do.	do.	1164
1451	Brown & Co.,	do.	do.	1160
1452	Thompson & Mechlin, . .	Fetzer & Myers Tract, .	do.	1162
1453	Mechlin, No. 1,	do. do.	do.	1170
1454	McKinney Bros.,	do. do. do.	do.	1171
1455	Ida,	do. do.	do.	1203
1456	Tom Collins,	do. do.	do.	1216
1457	Galey,	do. do.	do.	1229

Wells between Millerstown and St. Joe.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1458	McKinney, No. —, . . .	Hemphill (heirs) Farm, .	Donegal,	1225
1459	McKinney, No. 12, . . .	do. do.	do.	1277
1460	McKinney, No. 13, . . .	do. do.	do.	1304
1461	McKinney, No. 17, . . .	do. do.	do.	1366
1462	McKinney, No. 19, . . .	do. do.	do.	1387
1463	Angel Gas Well,	Dugan Farm,	do.	1295
1464	Diviner, No. 1,	Diviner Farm,	do.	1262
1465	Diviner, No. 2,	do. do.	do.	1279
1466	Diviner, No. 3, ? . . .	do. do.	do.	1379
1467	Diviner, No. 3, ? . . .	do. do.	do.	1302
1468	Diviner, No. 4,	do. do.	do.	1332
1469	Diviner, No. 5,	do. do.	do.	1375
1470	Diviner, No. 6,	do. do.	do.	1385
1471	Diviner, No. 7,	do. do.	do.	1374
1472	Grace, S. & T.,	Fetzer & Myers Tract, .	do.	1381
1473	Grace, F. & M.,	do. do. do.	do.	1402
1474	Weiser,	McGinley Farm,	do.	1350
1475	Caldwell & Emery, . . .	do. do.	do.	1357
1476	Shamburg & O'Hara, . .	do. do.	do.	1397
1477	Prentice, No. 1,	do. do.	do.	1411
1478	Prentice, No. 2,	do. do.	do.	1374
1479	Prentice, No. 3,	do. do.	do.	1404
1480	Adams & Friday,	do. do.	do.	1379
1481	McGinley, No. 3,	do. do.	do.	1393
1482	Black Maria,	do. do.	do.	1353

	NAME.	Locality.	Township.	Elevation ab. ocean.
1483	Busted Ring,	McGinley Farm,	Donegal,	1330
1484	Hart & Conkle,	do. do.	do.	1348
1485	Relief, No. 1,	do. do.	do.	1409
1486	Relief, No. 2,	do. do.	do.	1363
1487	Hunter, No. 1,	do. do.	do.	1294
1488	Hunter, No. 2,	do. do.	do.	1295
1489	Scudder,	?	do.	1264
1490	Smith,	Dugan (?) Farm,	do.	1382
1491	Overy, No. 12,	E. Duffy Farm,	do.	1369
1492	O'Reilly,	do do.	do.	1339
1493	M'Allister, No. 1, . . .	McAllister Farm,	do.	1318
1494	McAllister, No. 3, . . .	do. do.	do.	1399
1495	McAllister, No. 5, . . .	do. do.	do.	1353
1496	Overy, No. 2,	McLaughlin Farm,	do.	1361
1497	Overy, No. 6,	do. do.	do.	1335
1498	Overy, No. —,	do. do.	do.	1355
1499	Overy, No. —,	Murphy Farm,	do.	1292
1500	Gillespie,	Gillespie Farm,	do.	1329
1501	Burchfield, No. —, . . .	do. do.	do.	1321
1502	Prentice,	C. Duffy Farm,	do.	1289
1503	Lechner,	Lechner Farm,	do.	1359
1504	Tanner,	McGuire Farm,	do.	1316
1505	Showalter,	do. do.	do.	1363
1506	Oakland, No. 4,	do. do.	do.	1361
1507	Bronson & Harrington,	Boyd Farm,	do.	1367
1508	Bronson & Harrington, No. —,	do. do.	do.	1389
1509	Bronson & Harrington,	do. do.	do.	1400
1510	Riddle or Overy, No. 5,	P. Murphy Farm,	do.	1371
1511	Mead, No. 2,	J. Now Farm,	do.	1335
1512	Mead, No. 3,	do. do.	do.	1390
1513	Mead, No. 1,	do. do.	do.	1294
1514	Bulger,	do. do.	do.	1368
1515	Shidemanite,	P. McGuire Farm,	do.	1399
1516	Maid, No. —,	do. do.	do.	1316
1517	Maid, No. —,	do. do.	do.	1366
1518	Emerson,	J. Neff Farm,	do.	1388
1519	Bulger,	J. Graham Farm,	do.	1346
1520	Armor,	do. do.	do.	1400
1521	Burchfield,	Graham (?) Farm,	do.	1379
1522	— Well, No. 3,	do. do.	do.	1346

Wells at Jeffersonville and Herman Station.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1530	Humes, No. 1,	Humes Farm,	Clearfield,	1124
1531	Humes, No. 2,	do. do.	do.	1161
1532	Summit, (No. 1,)	Eichenlaub Farm,	Summit,	1326
1533	Herman Oil Co., No. 2,	do. do.	do.	1281
1534	Hunter,	Schnure Farm,	do.	1191
1535	Kirk & Dilworth, . . .	Bingham Farm,	Jefferson,	1263

Wells near St. Joe and Carbon Centre.

	NAME.	Locality.	Township.	Elevation ab. ocean.
1523	Bonanza,	O'Donnell Farm,	Donegal,	1398
1524	Fletcher, No. 3,	P. Duffy Farm,	do.	1212
1525	Weiser,	do. do.	do.	1216
1526	Burns Gas Well,	do. do.	do.	1298
1527	Prentice, No. 3,	do. do.	do.	1309
1528	Shirley,	do. do.	do.	1222
1529	R. Thompson Gas Well,	Robt. Thompson Farm, . .	Clearfield,	1162

§ 87. *Oil Well Records.*

The following well records have been taken from Report I.I, and are here reproduced to illustrate the general stratigraphy of the Butler County Oil District.

Where coal beds are reported in these records I have inserted their names, but otherwise the records remain unchanged in the "Drillers' Nomenclature." A "shell" is any hard stratum encountered by the drill, and is generally a thin band of muddy or silicious sandstone, often pebbly: "SS." is an abbreviation for sand or sandstone, and "soapstone" is the driller's name for shale, or soft slaty shale. The term "Red Rock" explains itself.

These records are all very reliable ones, and correctly represent the thicknesses and character of the various rocks passed through.

The six detailed records numbered from (1199) to (1204) were carefully kept by Mr. John H. Carll, who preserved sand-pumpings from each stratum, and accurately measured their depth with a steel wire. They are fully described in Report I.I.I.

It will be observed that these wells are numbered on the left side by the original running numbers of report I.I.

(1130) Columbia Oil Co. Well No. 4.

January 10, 1876.

On Reddick Farm, Columbia Hill, two miles N. W. of

Parker, in Allegheny Township, Butler County. Authority, Columbia Oil Company.

Well mouth above ocean in feet,			
Conductor, clay,	18 to	18 =	
Slate, black,	70 to	88 =	
Limestone, black, . Ferriferous Limestone,	10 to	98 =	
Soapstone,	57 to	155 =	
SS., 60' rock,	} Beaver River Series.	60 to	215 =
Slate, hard shells, gray,		60 to	275 =
SS., fine grained, hard and gray,		10 to	285 =
Slate, black,		20 to	305 =
Slate, shelly,		45 to	350 =
Mountain SS.,		100 to	450 =
Slate, with gray shells,		300 to	750 =
SS., gray, hard,		20 to	770 =
Slate,		120 to	890 =
Slate, white,		55 to	945 =
1st SS., with some gas,		60 to	1005 =
Red rock,		35 to	1040 =
2d SS., oil show,		40 to	1080 =
Slate,		2 to	1082 =
SS.,		35 to	1117 =
Soapstone,		23 to	1140 =
SS.,		28 to	1168 =
Soapstone,		30 to	1198 =
SS.,		8 to	1206 =
Soapstone,		2 to	1208 =
SS.,		12 to	1220 =
Soapstone,		30 to	1250 =
3d SS.,		27 to	1277 =
Slate,		pool, 3 to	1280 =

Drilled dry. Cased at 291'. Gas sufficient to fire 5 boilers. Best oil indications at 1259'. Best production, 15 barrels per day. Average to August, 1876, $3\frac{1}{2}$ barrels per day. Green oil.

(1139) *Gibson & Ecock Well.*

On Fronsinger farm, Parker township, Butler county. Authority, Edward Casey.

Well mouth above ocean in feet,		1382
Clay,	14 to	14 = 1368
Surface SS.,	15 to	29 = 1353
Slate,	51 to	80 = 1302
SS., white,	7 to	87 = 1295
COAL, Freeport Lower,	3 to	90 = 1292
SS., dark, 15'; white, 35' . dark, 5',	55 to	145 = 1237
COAL, Kittanning Upper,	5 to	150 = 1232

SS. (Sandstone,)	8 to 153 =	1229
Slate,	182 to 285 =	1097
Limestone, . . . Ferriferous Limestone,	15 to 300 =	1092
COAL,	3 to 303 =	1079
Slate,	60 to 363 =	1019
SS., white,	37 to 400 =	982
Slate,	45 to 445 =	937
Bluff SS., "A,"	19 to 464 =	918
Slate,	10 to 474 =	908
Bluff SS., "B,"	18 to 492 =	890
COAL,	6 to 498 =	884
Mountain SS., (with Slate at 568 to 569 and 569 to 607,)	144 to 642 =	740
Slate,	30 to 672 =	710
Shells,	20 to 692 =	690
Slate,	15 to 707 =	675
SS.,	12 to 719 =	663
Slate,	30 to 740 =	633
Shells,	25 to 774 =	608
SS.,	20 to 794 =	588
Slate,	31 to 825 =	557
1st SS.,	12 to 837 =	545
Slate,	85 to 922 =	460
Shells,	2 to 924 =	458
Slate,	135 to 1059 =	323
SS.,	8 to 1062 =	320
Slate,	90 to 1152 =	230
SS.,	2 to 1154 =	228
Slate,	6 to 1160 =	222
2d SS.,	10 to 1170 =	212
Red rock,	2 to 1172 =	210
SS., fifty foot rock,	15 to 1187 =	195
Red rock,	2 to 1189 =	193
Slate and shells,	8 to 1197 =	185
Red rock,	4 to 1201 =	181
SS., white,	9 to 1210 =	172
Slate and shells,	10 to 1220 =	162
SS., dark,	15 to 1235 =	147
Slate,	25 to 1260 =	122
SS.,	30 to 1290 =	92
Slate,	5 to 1295 =	87
SS., Blue Monday,	5 to 1300 =	82
Red rock,	12 to 1312 =	70
SS.,	4 to 1316 =	66
Red rock,	7 to 1323 =	59
SS.,	12 to 1335 =	47
Slate,	10 to 1345 =	+ 37
SS., boulder,	4 to 1349 =	+ 33
Red rock,	2 to 1351 =	+ 31
Slate,	10 to 1361 =	+ 21
SS., stray,	12 to 1373 =	+ 9
Slate,	4 to 1377 =	+ 5
SS.,	6 to 1383 =	- 1

Slate,	3 to 1386 = —	4
SS.,	4 to 1390 = —	8
Slate,	8 to 1393 = —	11
SS.,	6 to 1399 = —	17
Slate,	3 to 1402 = —	20
SS., oil sandrock,	16 to 1418 = —	36

(1170.) *Mattison and McDonald Well.*

December 4, 1875.

On McClyman's farm, Fairview township, Butler county.
 Authority, John Davitt.

Well mouth above ocean in feet.		+1244
Conductor (?) 10', shale 4', COAL 4',	18 to	18 = +1226
Slate,	23 to	41 = +1203
COAL, Kittanning Upper,	4 to	45 = +1199
Slate,	25 to	70 = +1174
Bluff SS. (Sandstone,)	75 to	145 = +1099
Slate,	20 to	165 = +1079
Limestone, Ferriferous Limestone,	20 to	185 = +1059
Slate,	143 to	328 = + 916
SS. forty foot rock,	40 to	368 = + 876
Slate,	110 to	478 = + 766
Mountain SS.,	150 to	628 = + 616
Slate,	122 to	750 = + 494
1st SS.,	20 to	770 = + 474
Slate,	200 to	970 = + 274
SS.,	10 to	980 = + 264
Slate,	185 to	1165 = + 79
2d SS.,	20 to	1185 = + 59
Red Rock,	5 to	1190 = + 54
Slate,	80 to	1270 = — 26
SS., Blue Monday,	10 to	1280 = — 36
Red Rock,	20 to	1300 = — 56
Slate,	20 to	1320 = — 76
SS., boulder,	10 to	1330 = — 86
Slate,	20 to	1350 = — 106
Stray 3d SS.,	25 to	1375 = — 131
Slate,	15 to	1390 = — 146
3d SS.,	12 to	1402 = — 158
Slate,	58 to	1460 = — 216
Stray 4th SS.,	8 to	1468 = — 224
Slate,	2 to	1470 = — 226
4th SS., 20' in sand,	20 to	1490 = — 246

Cased at 470'. Gas sufficient to fire one boiler.

Best production, 75 barrels per day. Amber green oil.

(1173.) *Mead Well.*

On Now farm, near St. Joe, Donegal township, Butler county. Authority, Mr. Wyatt; from memory.

Well mouth above ocean in feet,		+1294
?	40 to 40 =	+1254
COAL, Millerstown Bed,	5 to 45 =	+1249
?	300 to 345 =	+ 949
Limestone, . . . Ferriferous Limestone ,	20 to 365 =	+ 929
?	35 to 400 =	+ 894
SS., 60' rock,	60 to 460 =	+ 834
?	35 to 495 =	+ 799
SS., 40' rock,	40 to 535 =	+ 759
Slate,	20 to 555 =	+ 739
Mountain SS. Cased at 537',	175 to 730 =	+ 564
Slate,	405 to 1135 =	+ 159
1st SS.,	25 to 1160 =	+ 134
Slate,	110 to 1270 =	+ 24
2d SS. (Second Sandstone),	25 to 1295 =	- 1
Red rock,	5 to 1300 =	- 6
SS., 50' rock,	40 to 1340 =	- 46
Slate,	20 to 1360 =	- 66
SS., 30' rock,	25 to 1385 =	- 91
Slate,	40 to 1425 =	- 131
SS., boulder,	20 to 1445 =	- 151
Slate,	10 to 1455 =	- 161
SS., Blue Monday,	5 to 1460 =	- 166
Slate,	40 to 1500 =	- 206
Stray 3d SS.,	30 to 1530 =	- 236
Slate,	25 to 1555 =	- 261
3d SS., 10' in sand,	10 to 1565 =	- 271

(1175.) *Thompson Gas Well.*

Robert Thompson farm, Clearfield township, Butler county, 2 miles south of St. Joe, and adjoining the Easterling farm. Drilled in 1875. Authority, S. McGara.

Well mouth above ocean in feet,		+1162
Conductor,	15 to 15 =	+1147
Slate,	8 to 23 =	+1139
SS., surface sandstone, coal show 30',	100 to 123 =	+1039
Slate, good drilling,	92 to 215 =	+ 947
Limestone, soft and poor— Ferrif. Limestone ,	15 to 230 =	+ 832
Slate, good drilling,	60 to 290 =	+ 872
SS. (Sandstone), white, "open,"	40 to 330 =	+ 832
Slate,	60 to 390 =	+ 772
SS., "60' SS.,"	90 to 480 =	+ 682
Slate,	50 to 530 =	+ 632
Mt. SS., little salt water top and bottom,	210 to 740 =	+ 422

Slate,	100 to 840	= + 322
SS., little salt water and gas,	22 to 862	= + 300
Slate, shelly,	150 to 1012	= + 150
SS., very hard,	22 to 1034	= + 128
Slate, shelly,	143 to 1177	= - 15
SS., very dark, little salt water,	15 to 1192	= - 30
Red rock, very hard,	7 to 1199	= - 37
Slate,	8 to 1207	= - 45
SS., "50' rock," top, hard; bottom, soft,	50 to 1257	= - 95
Slate,	20 to 1277	= - 115
SS., "30' rock," red at bottom,	20 to 1297	= - 135
Slate,	60 to 1357	= - 195
SS., white,	5 to 1362	= - 200
Red rock, hard,	15 to 1377	= - 215
SS., boulder,	10 to 1387	= - 225
Slate,	38 to 1425	= - 263
SS., "Corn-meal" or stray, good,	21 to 1446	= - 284
Slate,	10 to 1456	= - 294
3d SS., (measured,)	30 to 1486	= - 324
?	52 to 1538	= - 376
4th SS., gas, no oil,	207 to 1558	= - 396

Drilled dry. Cased at 461'. The 3d SS. was full of small pebbles near its top, but became fine, white and sharp toward the bottom. Oil was struck near the top of this sand. The well was tubed and pumped for four months, producing eight barrels per day of good lively oil. The tubing was then drawn and the drill run down to the 4th SS., which was found at 1,538'. A powerful vein of gas was encountered here, the rig caught fire and burned down, and as there is no oil with the gas the well is now only used as a gas well, supplying fuel to 15 or 20 boilers in the neighborhood.

Slate, shale and sand shells,	dark on top, black on bottom,	145 to 935 =	501
SS.,	hard and white,	5 to 940 =	496
Slate,	clean, bluish-grey,	30 to 970 =	466
SS.,	shaly, grey,	20 to 990 =	446
Shale,	slaty, bluish-grey, with a gas vein at 1190' in a thin shell of fine bluish SS.,	260 to 1250 =	186
Shale,	sandy, with a few yellow pebbles, bluish,	52 to 1302 =	134
Slate,	shaly, purplish,	34 to 1336 =	100
SS.,	pebbly, 8'		
SS.,	grey, 9'		
SS.,	slaty mixture, 12'		
SS.,	grey and fine, 12'		
Slate and shale,	"Second Sand,"	36 to 1573 =	64
SS.,	uniform, hard, white, "50' rock,"	38 to 1410 =	26
Slate,	blue,	22 to 1432 =	4
SS.,	homogeneous, fine, white, "30' rock,"	28 to 1460 =	24
Slate,	shelly blue,	42 to 1502 =	66
SS.,	yellowish-grey, fine "Boulder,"	8 to 1510 =	74
Slate,	blue,	14 to 1524 =	88
SS.,	grey, "stray 3d,"	6 to 1530 =	94
SS.,	pebbly,	16 to 1548 =	110
SS.,	white,		
SS.,	grey and hard,	20 to 1568 =	180
Slate,	shaly, dark blue,	40 to 1606 =	170
SS.,	dark "clover seed" pebble,		
SS.,	fine, white,	25 to 1631 =	195
SS.,	good white pebble,		

Drilled dry. Cased at 643'. A very little salt water below the casing.

Gas at 1190', half sufficient to fire the boiler with while drilling, but this gas was exhausted in three or four days. About the same amount of gas was found in the "2d sand."

Very little oil in the "3d sand." The hole filled up 300' or 400' with oil from the top of the "4th sand," and flowed when drilled a few feet deeper. No Red Rock found in drilling. Best daily production, 40 barrels.

(1900.) *Dougherty Well, No. 2.*

DECEMBER 7, 1876.

Owned by Dougherty and Devlin, and situated on the McCleary farm, Fairview township, Butler county, about 1 mile south 800 west of Petrolia, and $1\frac{1}{4}$ miles north 60° east from Sutton Well, No. 4.

Well mouth above ocean in feet,	1827
Conductor,	1817
SS.,	1812
Slate,	12.7
Limestone,	5 to 15 =
SS.,	55 to 70 =
Slate,	— to 70 =
SS.,	85 to 155 =
Coal,	51 to 206 =
Sand shells,	8 to 209 =
Slate,	1121
Limestone,	1118
Slate,	10 to 219 =
SS.,	1087
Limestone,	21 to 240 =
Slate,	20 to 280 =
SS.,	20 to 280 =
Slate,	80 to 360 =
SS.,	80 to 390 =
Slate,	50 to 440 =
SS.,	24 to 464 =
Slate,	8 to 472 =
SS.,	88 to 555 =
Slate,	27 to 582 =
SS., { top, fine yellow,	582
{ bottom, soft and gray,	58 to 675 =
{ "Mountain Sand,"	58 to 675 =

surface, yellow, bluish, thickness unknown, sandy; top blue, bottom gray and muddy, gray, slaty, hard and blue, dark, soft, dark, gritty, white, "sixty-foot rock," very dark, sandy, dark gray, hard, white, with layers of black slate, "twenty-foot rock," black, soft and gray on top, hard and white on bottom, dark, with gray sand shells, "Mountain Sand,"

Slate,	17 to 692	=	685
Slate and gray sand shells,	108 to 800	=	627
Slate,	125 to 925	=	402
Sand shells,	13 to 940	=	387
Slate,	100 to 1040	=	287
Slate,	80 to 1120	=	207
Slate,	58 to 1178	=	149
SS., hard and bluish gray, 12'			
SS., olive and gray, 20'			
SS., silty, 45'			
SS., fine gray, 10'			
Red rock,			
Sand shells and slate,			
SS., hard and white on top, yellowish-gray on bottom, "thirty-foot rock,"	1 to 1286	=	61
SS., "Blue Monday,"	48 to 1314	=	13
Red rock,	16 to 1330	=	3
Slate,	12 to 1342	=	15
SS., bluish,	21 to 1363	=	38
Slate,	10 to 1373	=	46
SS., very fine and light gray, "boulder,"	12 to 1395	=	58
SS., fine white,			
SS., "Stray Third,"	27 to 1412	=	85
Slate,			
SS. (about through), pebbly and white on top, fine and yellowish-gray at bottom,	8 to 1420	=	98
	16 to 1436	=	109

Drilled dry. Cased the first time at 478'. Flood of salt water at 570'. Casing pulled and put in the second time to a depth of 610', and found no water below this depth. A small amount of gas in the "2d sand." Oil in the "3d sand," at 1423'. Average daily production, 15 barrels.

(1901) Evans Well, No. 21.

DECEMBER 23, 1876.

Owned by Evans & Co., and situated on the Dougherty farm, Fairview township, Butler county, about four-fifths of a mile south 40° west of Petrolia, and about three-fourths of a mile south 40° east of the Dougherty Well, No. 2.

Well mouth above ocean in feet,	18 to 18 =	1388
Conductor,	162 to 180 =	1376
Slate and shale, with bluish-gray shells,	— to 180 =	1213
Limestone,	45 to 225 =	1213
SS.,	64 to 239 =	1168
Shelly shale,	1 to 230 =	1104
Coal,	4 to 234 =	1103
SS.,	43 to 337 =	1099
Slate and shells,	21 to 338 =	1053
Limestone,	18 to 376 =	1035
Slate,	4 to 380 =	1017
Coal,	6 to 3.6 =	1007
SS.,	60 to 452 =	941
Slate,	44 to 496 =	897
Slate, with dark sand shells,	50 to 546 =	847
SS.,	5 to 551 =	843
Slate,	35 to 586 =	807
SS.,	2 to 588 =	805
Slate,	9 to 597 =	796
SS., gray, occasional partings of dark slate,	148 to 745 =	648

Slate,	fawn-color and bluish,	20 to 765	=	628
Sand shella,	gray, with partings of slate and shale,	80 to 845	=	548
SS.,	flaggy, olive-gray,	50 to 895	=	498
SS.,	white,	35 to 930	=	463
Slate,	sandy, dark,	70 to 1000	=	398
Slate,	more shelly, dark gray,	100 to 1100	=	298
Slate,	muddy, dark,	100 to 1200	=	193
Slate,	sandy, dark,	74 to 1274	=	119
SS., fine, olive-gray,	"Second Sand,"	17 to 1291	=	102
Slate dark,	olive-gray, "fifty-foot rock,"	3 to 1294	=	99
SS., fine, with slate partings,	sandy, "thirty-foot rock,"	54 to 1348	=	45
Red rock,	dark, with gray sand shella,	13 to 1361	=	32
Slate,	hard, bluish-gray, "Blue Monday,"	36 to 1397	=	4
SS.,	hard slate,	8 to 1403	=	10
Red rock,	dark,	27 to 1430	=	87
Slate,	hard, olive-gray, "boulder,"	28 to 1459	=	66
SS.,	dark,	10 to 1469	=	76
Slate,	dark,	13 to 1481	=	83
SS., white,	"Stray Third,"	25 to 1506	=	113
Slate,	dark,	7 to 1513	=	120
SS., pebbly, coarse, gray,	"Third Sand,"	15 to 1528	=	185
Slate, shelly, purplish,	trace of red rock at 1,565',	53 to 1586	=	193
SS., pebbly, coarse, white,	"Fourth Sand,"	23 to 1608	=	215
Slate,	very dark,	8 to 1616	=	223

Drilled dry. Cased at 705', and found no water below casing. A little gas at 1120'. Oil at 1519', and no increase of oil in the "4th sand." Torpedoed, but no apparent increase of oil. Pumped about 1½ barrels of oil per day. Torpedoed a second time, and after that said to be averaging 10 barrels per day.

Slate,	dark,	100 to 770	=	528
Slate,	sandy and hard,	87 to 807	=	491
SS., fine and hard,	top grey, bottom very dark,	28 to 895	=	463
Slate,	bluish,	100 to 985	=	863
Slate,	shelly,	90 to 1025	=	273
SS.,	dark grey,	10 to 1035	=	263
Slate,	sandy, dark,	50 to 1085	=	213
Slate,	dark,	70 to 1155	=	143
Slate,	purplish,	52 to 1207	=	91
SS.,	olive-grey,	6 to 1213	=	85
Red rock sandy,	chocolate color,	4 to 1217	=	81
SS., olive-grey, flakey,	"50' and 30' rocks,"	63 to 1280	=	18
Slate,	sandy, dark,	82 to 1312	=	14
SS.,	fine, dark grey, "Blue Monday,"	6 to 1318	=	20
Red rock,	soft, "Big Red Rock,"	18 to 1386	=	38
Slate,	dark,	20 to 1386	=	58
SS.,	grey, "Boulder,"	3 to 1359	=	61
Slate,	bluish,	23 to 1382	=	84
SS., with yellow pebbles,		29 to 1411	=	113
Slate,	dark,	1 to 1412	=	114
SS., coarse and grey,		19 to 1431	=	133
Slate,	dark,	19 to 1450	=	152
Red rock,		8 to 1458	=	100
Slate,	purplish,	24 to 1482	=	184
SS., yellowish-grey,	very fine at bottom,	27 to 1509	=	211
Slate,	very dark,	3 to 1512	=	214

Drilled dry. Cased at 486'. A little salt water in the "Mountain sand," below the casing, about half enough to drill with. Very little gas in the "2d sand." Oil in the "3d sand" at 1415', and no increase in the "4th." Torpedoed before being tubed with no apparent increase of oil. Average daily production, 15 barrels.

(1903.) *Morehead and Lardin Well, No. 2.*

JANUARY 6, 1877.

Owned by Morehead, Lardin & Co., and situated on the Mortimer farm, Fairview township, Butler county, about four fifths of a mile east of Petrolia, and three fourths of a mile north 55° east of Hazelwood Well, No. 21.

Well mouth above ocean in feet,	1420
Conductor,	1415
Slate, muddy; trace of Lower Freeport Limestone and Coal , . . . reported at about 70',	1310
SS., gray, trace of coal at the bottom,	1186
Slate, black,	1160
Shelly gray sand and very black slate,	1092
Limestone, interstratified,	1074
Slate, very dark,	1054
Slate, muddy, bluish-gray,	1033
SS., gray, "sixty-foot rock,"	985
Slate, with blue sand shells,	948
SS., white, with trace of coal,	928
SS., gray, with slate partings,	900
Slate, black, with gray sand shells,	869
SS., "Mountain Sand," ,	680
SS., coarse, white, 69'	680
Slate, common,	680
SS., flaky, gray, micaceous, 30'	454
SS., muddy, gray, 100'	
SS., fine, muddy, gray, 76'	

SS., hard, gray, with films of coal, 20'

SS., fine, grayish white, 90'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

SS., fine, muddy, gray, 76'

Slate,	75 to 1041 =	379
Shells,	10 to 1051 =	369
Slate,	100 to 1151 =	269
Slate,	85 to 1186 =	234
Slate,	94 to 1280 =	140
SS., with slate partings, muddy, olive-gray, "Second Sand,"	38 to 1318 =	102
Red rock,	— to 1318 =	102
Slate,	65 to 1383 =	37
SS.,	15 to 1398 =	22
Slate,	84 to 1432 =	12
SS.,	10 to 1442 =	22
Red slate,	24 to 1466 =	46
Slate,	27 to 1493 =	73
SS.,	4 to 1497 =	77
Slate,	8 to 1500 =	80
SS., top greenish, middle yellowish, "Stray Third,"	18 to 1518 =	98
Slate,	10 to 1528 =	108
SS., (1) large white pebbles, (2) very fine gray sand, (3) very fine white sand, (4) very fine gray sand, "3d sand," (not through) "Third Sand,"	21 to 1549 =	129

Drilled dry. Cased at 528' and no water found below the casing. A little gas in the "2d sand." Oil in the "3d sand" at 1530'; flowed at 1545'. Average daily production, 12 barrels.

Slate and shale, with thin shells,	dark gray, muddy,	148 to 1140	=	324
Shells,	hard and gray,	10 to 1150	=	314
Slate, with shells, dark gray,	trace of red and a few yellow pebbles at 1194,	110 to 1260	=	204
Slate,	soft and muddy, lead color,	77 to 1337	=	127
SS., grayish white,		5 to 1342	=	122
Slate,		6 to 1343	=	116
Red rock,	"Big Red Rock,"	17 to 1365	=	99
Slate and shale,	soft,	53 to 1418	=	46
SS.,	slaty, gray,	14 to 1432	=	32
Red rock,		8 to 1440	=	24
Slate,	dark,	40 to 1480	=	16
Sandy shale,		15 to 1495	=	31
Red rock,		8 to 1498	=	34
Sandy shale,		17 to 1515	=	51
Red rock,		2 to 1517	=	53
Shale,	dark olive-gray,	23 to 1540	=	76
Red rock,		5 to 1545	=	81
Shale,	dark olive-gray,	15 to 1560	=	96
SS.,	pebbly, black, "boulder,"	5 to 1565	=	101
Slate,	dark, gray,	4 to 1569	=	105
SS., top pebbly, white, bottom fine sand, Third Sand,		28 to 1597	=	133
Slate,	bluish,	18 to 1610	=	146

Drilled dry. Cased at 617', and no water found below the casing. A little gas at 1138', and show of oil. Oil in the "3d sand" at 1570'. Average daily production, 12 barrels.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS, V

1875.

By H. MARTYN CHANCE.

PART II.

BEAVER AND SHENANGO VALLEYS,

IN

BEAVER, LAWRENCE AND MERCER
COUNTIES.

CHAPTER I.

The Mercer Group traced continuously along the hillsides from Wirtemburg to Sharon.

This survey was made to determine the horizon of the Sharon Coal bed with reference to the Lower Productive Coal measures, and with respect to No. XII,—the Coal Measure Conglomerate. The report upon it was written in the winter of 1875, but unavoidable delays have hindered its publication, until now its results have been anticipated in Mr. White's detailed county reports on Beaver, Lawrence, and Mercer counties. His conclusions tally remarkably with those that I arrived at in 1875, but since that time my views regarding the basal limits of No. XII have been greatly modified by knowledge of these rocks that I have obtained in the oil regions.

A map (Plate VI) showing the position of all the sections here given, has been constructed partly from the alignment notes of the New Castle and Homewood, and Erie and Pittsburgh Railroads, and partly from original surveys. These surveys were made with a large six inch needle mining compass, with a ten inch telescope with arm for reading vertical angles and stadia wires attached.

The Ferriferous Limestone and Darlington (Kittanning Middle) Coal bed are shown on the map by their outcrop lines; and the positions of the Mercer Group and Sharon Coal bed are added at points where they could be definitely located. The longitudinal profile cross-section illustrates their geological and hypsometrical relations, and shows very prominently the great band of sandy measures now recognized as forming No. XII—"The Beaver River" or "Conglomerate Series."

The tidewater elevations are based on railroad levels and are very approximately correct.

Systematized Section of the Lower Productive Coal Measures.

Minima.	Maxima.	Average.
		Coal—Freeport Upper (?)
		or Lower (?) 6'
		Fireclay, 3'
		Shales, 58'
		Coal, (Eichenhaur ?) Free-
		port Lower, ? 1'
		Shaly sandstone Freeport
		Lower, 50'
		Kittanning Upper coal, not noted.
		Slate, 23'
2' 0" to 3' 6"		Kittanning Middle coal, . . 3'
4' 0" to 8' 0"		Fireclay, 5'
20' to 40'		Slate and shale, 35'
0' to 1' 6"		Kittanning Lower coal,
		(cannel,) 1'

—	to 10'	Fireclay,	5'
10'	to 30'	Shale and slate, sometimes sandy,	30'
0'	to 4'	Ore,	2'
—	to 22'	Ferriferous Limestone, .	15'
15'	to 25'	Slate, with Scrubgrass coal, 20'	
8"	to 1' 6"	Clarion coal,	1'
20'	to 45'	Shale and slate,	35'
0'	to 2'	Brookville coal	1'
1'	to 3'	Fireclay,	2'
5'	to 15'	Slate,	10'
0'	to 60'	Homewood Sandstone, top of No. XII,	30'
5'	to 15'	Slate,	11'
0'	to 3'	Mercer Upper Lime- stone,	2'
0'	to 2'	Mercer Upper coal,	1'
5'	to 20'	Ferriferous shales,	15'
0'	to 2'	Mercer Lower Lime- stone,	1'
0'	to 10'	Shale,	5'
0'	to 2'	Mercer Lower coal,	1'
0'	to 10'	Shale,	5'
10'	to 60'	Connoquenessing Upper Sandstone,	35'
0'	to 50'	Shale, with iron ore and "Strawbridge coal," .	25'
20'	to 60'	Connoquenessing Lower Sandstone, (sometimes double, with a small coal near middle,) . .	55'
0'	to 40'	Slate and shale,	25'
0'	to 4' 6"	Sharon Coal bed,	3'
0'	to 25'	Dark shale and slate, . .	11'
10'	to 40'	Sandstone—upper part of Ohio Conglomerate, .	25'
Shales and flaggy sandstones at Sharon.			

Mercer Group, 41'.

Beaver River Series, No. XII. 250'.*

V. 126



See Chapter II for discussion of this thickness.

South of New Castle the Ferriferous Limestone was used as a key rock, but after passing into the country north of the Neshannock the Mercer Group of limestones, coals, fireclays and iron ores was taken as a datum plane and everything (both above and below) referred to it.

In the following sections I have adopted the nomenclature used in the Butler county report, using the names Kittanning Upper, Middle, and Lower Coal beds.

The generalized description illustrated by Fig. 126, embraces all the data of the detailed sections, showing the maximum and minimum thickness of each interval, and the distance of one stratum from another by addition of the figures in the right hand column.

The general parallelism of the measures is unchanged by the thinning or thickening of an individual stratum, as such variations are nearly always compensated by an opposite change in the overlying or underlying interval.

The upper rocks of this section were measured in but two localities, viz: Wirtemberg and Wampum, and at these places the exposures were poor.

The Kittanning coals and Ferriferous limestone were traced up the Beaver as far as New Castle, but were not measured in the summits north of New Castle, but the Mercer Group was traced all the way to the Sharon coal field.

The Sharon Coal bed underlies the Upper Mercer Limestone from one hundred and sixty to one hundred and seventy-five feet, and between them the two Connoquenessing Sandstones* are found, which sometimes unite to form one

*The Homewood Sandstone and Connoquenessing Sandstone in my original manuscript were called the Upper and Lower Beaver Conglomerates, but I have altered these names to conform to Mr. White's nomenclature. As it is often difficult to recognize the upper and lower divisions of the Connoquenessing sandrock, it would be much better to call them the Connoquenessing Group of Sandstones. We would then have :

Coal	{	Homewood Sandstone.	
Measure		Mercer Group	—Coals.
Conglomerate		Connoquenessing Group	—Sandstones
No. XII =		Sharon Group	—Coal and Shale.
Beaver River Series.		Ohio Conglomerate.	

very thick rock, but at times consist of four or five members.

Both of the Mercer Limestones were seldom seen in one locality one or the other generally being absent, and it is often difficult to tell to which of the two the one noted should be referred, but the group of slates, shales, fireclays and coals in which they occur can never be wrongly identified. This group occurs beneath the Homewood Sandstone, and from 80 to 130 feet beneath the Ferriferous Limestone, the Upper Mercer Limestone usually occurring at from 90 to 115 feet beneath that stratum.

As described by Prof. Lesquereux (Report J, 1874) the Mercer Group at Wirtemberg consists of the succession represented on an enlarged scale in Fig.

127.

Wirtemberg Section.

Shale.

Limestone, hard and black,	3'
Fireclay,	2'
Sandstone,	5'
Soft greyish shales,	15'
Limestone (fucoidal)	1'
Coal,	5" to 1'
Shale, black soft, with iron ore to	

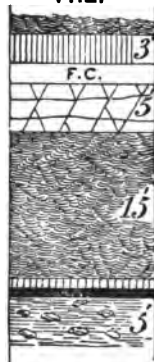
water level, 5' to 8'

In this vicinity the Homewood Sandstone has thinned down to a knife edge, and finally disappears, only however to reappear again farther up the stream. The Connoquenessing Sandstone is beneath stream level near Wirtemberg, but at Rock Point, at the mouth of the Connoquenessing, it forms rugged perpendicular bluffs one hundred feet high.

Going south and west from Wirtemberg no good development of the Mercer Group is found. Its place is often entirely occupied by the Homewood and Connoquenessing Sandstones which frequently are almost united.

At Homewood Furnace the measures have been pretty thoroughly explored in search after coal and iron ore, but

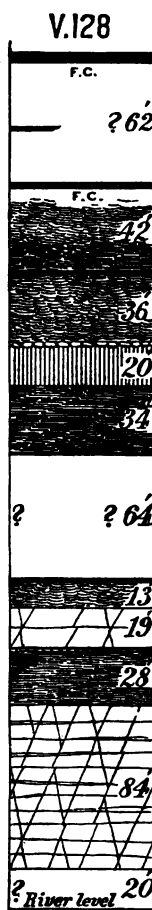
V.127



most of the openings and diggings are now partly or altogether closed, and accurate measurements of the individual beds could not be made. Fig. 128 illustrates the following description, which was compiled from exposures in this neighborhood:

Homewood Furnace Section.

1160'±	Coal . Freeport Lower?	6'
	Fireclay,	—
	Interval with coal (Kittanning Upper reported 1 ft.,)	62' (?)
1095'	Kittanning Middle Coal,	3'
	Fireclay,	—
	Shales and Slates,	42'
1052'	Kittanning Lower Coal (cannel)	1' 6"
	Slaty shales, brownish,	36'
	Ore variable, about	2'
1014'	Ferriferous Limestone, about	20'
994'	Slate,	34'
960'	Clarion Coal,	0' 6"
	Concealed—(distance $\frac{1}{2}$ mile)	64'
896'	Coal,	1' to 2'
	Shale and slate,	13'
883'	Massive Homewood Sandstone,	19'
864'	Coal,	0' 9"
	Iron ore—(Mercer limestone)	0' 8"
	Slate and shale,	28'
834'	Connoquenessing Sandstones, thin-bedded, fine-grained,	84'
	Unseen to river level,	20'



The thickness of the interval under the Clarion Coal bed is probably somewhat exaggerated by the sharp dip pervading the rocks near the furnace.

In going up the Connoquenessing from this point to the mouth of Slippery Rock Creek the Homewood Sandstone constantly thickens until at the latter place it measures sixty feet, and this too, but a short distance from the place of Prof. Lesquereux's section, where it is entirely wanting. Measurements made here give the section shown by Fig. 129.

Section at Slippery Rock Creek.

894'	Homewood Sandstone, hard and massive,	60'
834'	Slate, dark blue,	10'
	Coal (Mercer),	4" to 8"
	Connoquenessing Sandstone to low water in creek,	15'

V.129

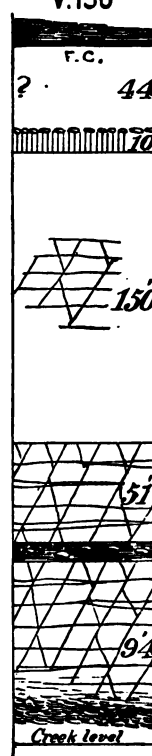


The slates occurring below these two sandrocks are quite soft and are very variable, changing from a few inches to as many feet in thickness in a distance of a few yards.

Section on Cunningham Farm.

	Slate.	
1076'	Coal,	2' 6"
	Fireclay,	—
	Interval,	44'
	Ore,	2'
1030'	Ferriferous Limestone, . . .	10'±
	Interval containing Homewood Sandstone, (massive,) . . .	150'
885'	Sandstone, massive,	51'
834'	Slate; blue, evenly laminated, with ore at base,	10'
824'	Sandstone, gradating downwards into sandy shale, and shale,	94'
	To water level at mouth of Connoquenessing,	0'

V.130



On Mr. Cunningham's farm between Wirtemburg and Homewood Furnace a coal is opened which lies in the horizon of the Lower Kittanning bed. It is about two and a half feet thick, and is mined during the winter months for local use. The limestone ore has been dug from several places on this farm, and carried to the furnace, a distance of about two miles. It is about two feet thick, but quite variable.

In descending from this Coal bank to the Creek, the section shown by Fig. 130, was measured.

The intervals of this section are somewhat enlarged by

the north dip of the Harrisville (?) anti-clinal axis, making the Conglomerate group about 30 feet thicker than what would be shown by a true vertical section.

On the east side of the river, and about a mile and a half south from the furnace, the section shown by Fig. 131 was measured.

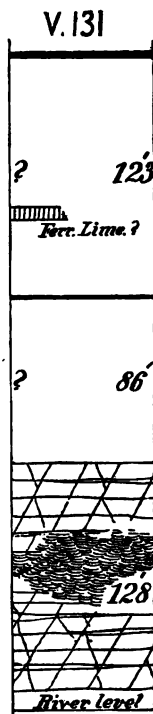
Section below Homewood Furnace.
Slate.

1068'	Kittanning Middle Coal, . . .	2' 11"
	Concealed: — Containing the horizon of the Ferriferous Limestone,	123'
944'	Clarion coal,	1'
	Fireclay,	—
	Interval,	86'
858'	Massive Homewood Sandstone with shale,	128'
730'	Sandstone, (Connoquenessing,) to River level,	

The Kittanning Middle Coal, which has been opened and worked quite largely, is here about 2' 11" thick, and is 27 feet lower than at Homewood Furnace. The Clarion Coal is exposed in a spring below this bank, but an accurate measurement of it could not be made. It is quite thin.

The Ferriferous Limestone could not be found in this immediate vicinity, and it is either quite thin or absent. Some ore has been dug from the shales overlying its horizon.

On the opposite side of the river, and about one and a half miles south from Clinton station, there are several quite interesting exposures from which the succession illustrated by Fig. 132 was compiled. This also fails to show the Ferriferous Limestone *in situ*, and it is more than probable that the place assigned to this stratum is about twenty feet too high in the measures. No sign of the rock was discovered in making these examinations, and its elevation, as given in the section, was determined from a terrace southeast of the clay bank, where it had been laid bare by plowing.



Clinton Section, No. 1.

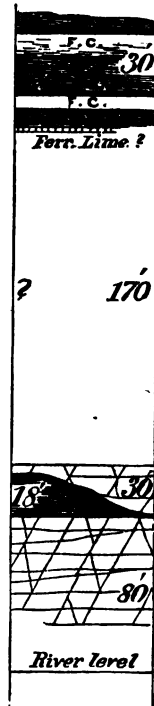
	Blue Slate.	
1057'	Kittanning Middle Coal, .	3'
	Fireclay,	—
	Slate,	30'
	Coal, . . . 0' 8" { Lower	
	Slate, . . . 1' 0" { Kitt. }	2' 1"
1025'	Coal cannel, 0' 5" {	
	Pottery clay,	8'
	Slate,	10'
1007'	Ferriferous Limestone,(?) .	(?) 1'
	Interval,	170'
837'	Homewood (?) Sandstone, 6' to 30'	
829'	Coal (Mercer ?) Beattie's	
	Bank,	2' 6"
	Slate,	18' to 0'
810'	Coal (Mercer ?)	1'
	Sandstone, }	80'
730'	Concealed to River, . . }	

At the time of making the above measurements, the Kittanning Middle bed was just being opened upon the farm owned by Mr. Beattie. The outcrop coal indicated a thickness of about three feet.

Thirty feet beneath this bed, comes the Lower Kittanning Coal which is here composed of a bituminous bench underlaid by a bench of cannel. It is too thin to be mined. Immediately under it there is eight feet of a beautiful pearly white and very fat clay. Mr. Baker the owner states that several experiments, many of which resulted favorably, have been made with it, and that he intends to bring it into the market as a pottery clay. It is the Lower Kittanning Fireclay which is so persistent over some areas, and sometimes attains a size of fifteen feet.

The coal overlying it is evidently the same with the bed noted in Fig. 128, and is usually a cannel in this vicinity, but always too thin to mine, and is seldom opened. The farmers are well aware of its existence, but know that it is worthless.

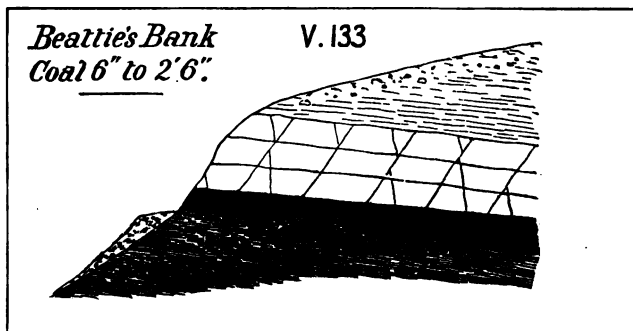
V.132



The most interesting part of the preceding section is, however, its lower portion. The Homewood Sandstone here lies quite low,* sinking far down into the horizon of the Mercer Group, and immediately beneath it there is a bed of quite good coal from 6 in. to 2 ft. 6 in. thick.

The latter has been opened by Mr. Beattie at a bank on the river bluff. Immediately above the entry there is six feet of hard massive sandstone, which a short distance north, swells downwards until it attains a size of thirty feet of hard massive conglomeratic sandrock, forming vertical cliffs, and covering the ground beneath with a talus of broken stone on which rest immense masses of rock in the shape of nearly rectangular blocks from 20 to 30 feet high.

The thickening of this rock cuts off the coal, which rests on a bed of slate that is also pinched out by it. Though it is a very irregular and uncertain bed, it yields very good coal at this bank. The sketch shown by Fig. 133 is intended to illustrate peculiar irregularities of its base, and is a conclusive proof that it had its origin in drifted carbonaceous matter, for how else could the peculiar "shoe" of coal be formed that is seen projecting from the bed downwards into the underlying slates.



The Connoquenessing (Lower?) Sandstone, lying near water level at this bank, is not a very prominent stratum, and is completely overshadowed by the more massive cliff rock above it.

*I am somewhat inclined to think this stratum may be a split from the Connoquenessing Upper rock. If it is the Homewood SS. its position is very remarkable lying as it does so far below the limestone.

In going up the valley from Baker's Bank to Rock Point, the west side of the river constantly presents steep, (in some places vertical) bluffs, the top rock of which is the Homewood Sandstone. On the east side of the river the side slopes are not so abrupt, but are still very steep. The scenery of the valley is in some places quite picturesque if not grand. The views obtained from Rock Point, especially in autumn when the forests first show their red and golden tints, are extremely beautiful. The romantic old dam with its lake-like waters to the north, the rushing torrent of the Connoquenessing on the east, hemmed in between rugged walls of rock, and the steep west bank with its vertical cliffs and a background of distant rolling summits of even contour with green fields and forests commingled, all combine in producing one of the most beautiful scenes in western Pennsylvania.

The section compiled at Clinton does not vary materially from the preceding one. It also exhibits the probable absence of the Ferriferous Limestone, but shows the presence of both the Kittanning beds and the Clarion coal bed. The interval from the latter to the Lower Kittanning is very small, being but 32 feet whereas it is usually about 80 feet.

This structure can only be explained by supposing that an ancient current eroded these slates and the Ferriferous Limestone. It is not at all improbable that such was the case, as at Homewood Mr. White has shown* that an ancient island or sand-bar of the Homewood Sandstone extends up to the horizon of the Ferriferous Limestone. This bar must have had some influence on the neighboring currents, or rather, they probably were instrumental in depositing it, and while depositing in one place, and subsequently to that deposition also, they must have effected more or less erosion at other points. One of these currents swept across the country near Clinton *after* the Ferriferous Limestone had been formed (or during its time of deposition) and effected (*by solution, not friction*) an erosion† that has produced the succession exhibited by Fig. 134:

* Report Q, Chapter VI.

† See foot-note Chapter X of this report.

Clinton Section No. 2.

	Slate.		V. 134
1031'	Kittanning Middle Coal, . . . 3'		
	Fireclay, —		
	Slate and shales, 38'		
992'	Kittanning Lower Coal, (can-		
	nel,) 1'		
	Slates—place of Ferriferous		
	Lime., (should be 80 ft. \pm), 32'		
959	Clarion Coal bed, 1'		
	Interval, 47'		
911	Brookville (?) Coal, 0' 9"		
	Iron ore, 0' 4" to 0' 8"		
	Interval, 15'		
896	Homewood SS.—massive, . 20'		
876	Coal, (Mercer Group,) . . . 0' 8"		
	Iron ore, (Mercer Upper Lime) 0' 6"		
	Slate, 20'		
	Sandstone, "Connoqueness." 70'		
	Shales, 56'		
730	River level, 0'		
	Interval, 40'		
	Sharon (?) Coal—in oil well, 4'		

The Brookville and Clarion coal beds retain their normal position in the above description, and the Mercer group is poorly represented by a thin, valueless coal, underlaid by a small bed of nodular iron ore, which possibly may be the Upper Mercer Limestone.

The Homewood Sandstone apparently lies rather low, but this is due to its diminished thickness. If it had its normal size of 35 feet, the section would more nearly conform to the average intervals. We would then have for the distance from the Homewood Sandstone down to the Sharon Coal bed 226 feet, which is within one foot (225') of the interval used in the Key Sections.

It is to be sincerely regretted that we could obtain no record of the strata beneath this coal, which is said to have been found at a depth of 40 feet in an old well drilled for oil near the mouth of Connoquenessing creek. A record

of the Wampum Oil Co's well gives (according to Mr. White) below this horizon: (See Fig. 134, lower part.)

"Hard white sandstone,	55'
Red rock, (iron ore?)	3'
Slate,	44'
Sandstone,	18'
Slate to bottom,"	0'

The "55 ft." rock is evidently the upper part of the Ohio Conglomerate, and the "18 ft." sand is the second member of the same rock, or the "ferriferous sandstone" of Mr. White's Sharon sections; giving a total of 120 ft. + 211 ft. = 331 feet from the top of the Homewood Sandstone to the base of the "ferriferous sandstone," or 120' + 226 ft. = 346 ft. The record above quoted only shows 294 feet for this interval, but in it the Homewood Sandstone lies quite low.

Mr. Mills, the foreman of Scott's banks at Clinton, states that in prospecting for coal with the drill, he passed through a few inches of what he supposed to be the Ferriferous Limestone, but was never able to find any surface exposures of it near the banks, and thinks that he was probably mistaken in his first conclusion, and that it is absent.

The rocks rise quite rapidly from Baker's Bank up to Clinton. On the east side of the river the rise is 883'—858' = 36 ft. in somewhat less than two miles, or at a rate of 19 ft. per mile. North of Clinton, and from that point to Wampum the rocks are quite flat. At Lee's Bank the coal is 1039 ft. above ocean level; at Davidson, Green and Co.'s Bank, 1036 ft., and at Wampum 1041 feet.

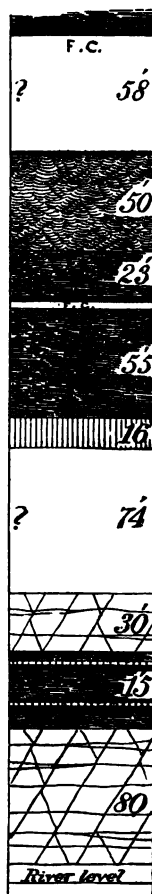
This flattening is occasioned by the Harrisville (?) synclinal, which crosses the Beaver near the mouth of Connoquenessing creek. The anticlinal crosses close to Homewood Furnace. In this vicinity the Harrisville axis is probably replaced by two minor rolls, one crossing at Homewood Furnace, and the other a short distance below it. Without a supposition of this kind, we are unable to account for the peculiar drainage feature noticed at the mouth of Slippery Rock creek, where the latter empties into the Connoquenessing from an exactly opposite direction to the

course of the latter. An anticlinal axis crosses the latter stream a short distance above the Slippery Rock's mouth, and its synclinal is distinctly seen at the confluence of the two streams, whereas the synclinal noticed on the Beaver crosses that stream between Clinton and Wampum. Neither of these axes are very prominent, and without the aid of accurate elevations would escape detection. They probably both die out in a southwesterly direction.

Wampum Section.

	Slate.	
1177'	Coal—Shannon's bank,	6'
	Fireclay,	3'
	Interval, about	58'
	Coal,	1'
	Sandy shales, about	50'
	Blue slate,	23'
1039'	Kittanning middle, (Lee's bank,) 3'	
	Fireclay, 4' to 8',	4'
	Slate,	55'
980'	Ferriferous Limestone, . 16' to 20'	
	Interval,	74'
890'	Homewood Sandstone, massive, 30'	
860'	Blue slate,	5'
855'	Mercer Upper Limestone,	2'
	Very bituminous shale, (coal,) 3'	
	Blue slate,	15'
	Black bituminous slate,	1'
	Mercer Lower Limestone,	1' 6"
	Very bituminous shale, (coal,) 3'	
	Slate, about	10'
	Connoquenessing Sandstone to level of Beaver River at 740'.	

V. 135



* When running my levels in this vicinity, I did not discover the exposures from which this part of the description was made. They were on a subsequent visit pointed out to me by Mr. White, who had been cognizant of their existence for some time. The thicknesses from the base of the Homewood Sandstone down to the Connoquenessing sandrock are only estimated by rough hand leveling, but are approximately correct.

At Wampum, quite a good series of exposures is seen, which, being compiled with corrections for dip, give the succession represented in Fig. 135, page 138.

The coal bed opened at Shannon's bank is either the Freeport Upper or Lower bed. As it is only found in the highest knobs with but little cover, and underlies a very small area, it can never be of much value. A few feet above it fragments of limestone were observed that looked very much like Freeport Upper Limestone.

From this coal down to the Middle Kittanning bed no good exposures were seen, and the measures in this interval are described from the record of a bore hole furnished by Mr. Mills, foreman of Scott's bank.

The Kittanning Middle Coal here lies remarkably close to the Ferriferous Limestone, but its position is readily explained by the erosion already described which has denuded the slates and shales of this horizon near Clinton. No trace of the Kittanning Lower Coal was detected, and it is probable that it has been swept away with its associate measures. If it is ever found in this vicinity, it will probably lie but a few feet below the former bed.

Between Clinton and Wampum, and from Wampum to New Castle, the Kittanning Middle bed furnishes excellent coal and is mined quite largely. Its best development occurs between the first named places. Lee's Bank at Clinton has a capacity of from 150 to 200 tons a day; with nearly three feet of good coal. The Wampum Bank can mine 100 tons, and has an average thickness of 2' 8", resting on a bed of underclay about 7 feet thick. The main entry runs through the hill, a distance of nearly one mile.

At Davidson Green and Co.'s bank the bed averages 2' 8". They mine 140 tons, but have a larger capacity.* The coal mined from the above banks is nearly all sent to New Castle for rolling mill and boiler use.

Both the Brookville and Clarion Coal beds are quite thin and impure in this section, and are opened at few places. No coal is mined from either of them.

The Homewood Sandstone (top of No. XII) is here pres

* In October 1875.

ent as a hard massive stratum thirty feet thick, jutting out in bold escarpments, and covering the surface with large rectangular blocks. Above Wampum it rapidly loses its hard and massive character, and changes to a very shaly rock which presents few outcrops. Its place is usually marked by a gentle terrace. At Hardscrabble opposite Newport it can barely be detected, and from this point northward to within two miles of New Castle no outcrop of it was found. At the upper end of Hog Hollow two miles south of New Castle several good exposures occur, but they will be described in connection with the exposures near New Castle.

A striking similarity will be observed by comparing the Mercer Group of the preceding section, with Prof. Lesquereux's description (see Fig. 127) of the same strata at Wirtzburg.

From Wampum northward, the two limestones of this group are seldom both present in one locality, or if present, both are rarely seen at one exposure. First one and then the other will apparently disappear, and it is often impossible to tell which of the two is present. The upper one seems to be rather more persistent than the lower, and is a purer limestone. It does not exhibit the fucoid markings (*Caulerpites margiuatus*, Lesqx) described by Prof. Lesquereux as occurring upon the lower bed.*

The Sharon Coal.

This bed should be found at from 30 to 60 feet beneath water level in the Beaver river between Wampum and Clinton, but it is very improbable that it will ever be found as a workable bed so far south of its best development, and even if such prove to be the case, it will be many years before the price of coal will warrant the prospecting, shafting, etc., necessary to open and mine it. On Slippery Rock creek a bed of coal is claimed to have been passed through by oil wells at a depth of 41 feet, which would about correspond to the horizon of this coal; and in a well sunk for oil

on the Beaver river near Connoquenessing creek, a coal bed four feet thick is said to have been struck at a depth of 50 feet. As beds of bituminous shale and black slate are often mistaken for coal by oil well drillers, little dependence should be placed upon any such reports.

A sharp local rise pervades the measures for a distance of from one and a half to two miles above Wampum, carrying up the Ferriferous Limestone and Middle Kittanning coal to a height of 70 or 80 feet above their elevations at the latter place.

The limestone is 12 feet thick and is found at an elevation of 1052 feet, with the coal 72 feet above it, and about two feet and a half thick. Beneath the latter is an immense bed of fireclay which measures 15 or 16 feet and accounts for the increase in the interval between the coal and limestone.

Hog Hollow Section, No. 1.

Slate.

1124', 1114', 1151', Kittanning Middle

Coal, 2' 6"

Fireclay, —

Interval, 72', 70', 97'

1052', 1044', 1054', Ferriferous Lime-

stone, 20'

1034, Interval, about 91'

943, Coal (Brookville? Mercer?) . . . 1'

Interval, (soft rocks,) . . . 33'

910' Coal, Mercer, thin.

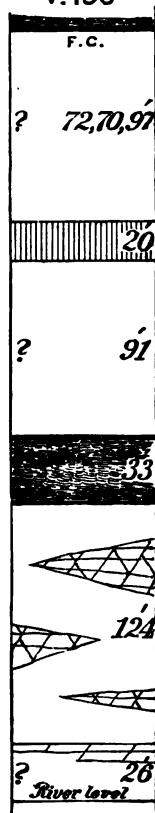
Interval (Shaly SS.,) . . . 124'

786' White friable sandstone, 8'

750' Concealed to river, 26'

In Hog Hollow the Ferriferous Limestone is frequently seen in bold escarpments, jutting out on both sides of the valley. It has been quarried very little. The Middle Kittanning coal is opened and worked for local consumption at a number of banks. It averages two and a half feet and is a very fair coal.

V. 136



Where first observed the limestone lies at an elevation of 1044 feet and ranges from 15 to 20 feet in thickness with the coal 70 feet above it. This shows a local *north dip* of 8 or 10 feet from the last locality, a distance of about one mile. The south dip however soon re-asserts itself, and one mile farther north we see the former at 1054 feet with the coal 97 feet above it.

The sudden increase in this interval is probably due to the fact that we have here passed the area over which it suffered from the ancient denudation so marked at Clinton, and reached a position in the old sea bed where these materials were redeposited in stiller water.

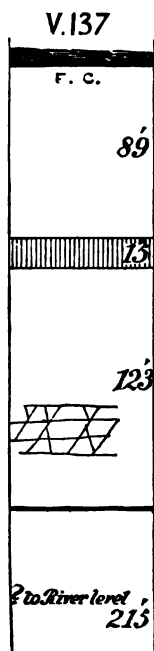
In going from Hardscrabble to this point, the succession shown in Fig. 136 was observed.

The section compiled at Moravia is quite similar to this one, and need not be given. The limestone is worked at Mr. John Shinn's quarry, where from 50 to 75 tons per day are taken out. At the time of visiting it most of the stone was being sent to Leetonia, Ohio. Its top is 1060 feet above ocean level and 93 feet beneath the Kittanning Middle Coal which is there 2' 6" thick.

Returning to Hog Hollow we find about one and a half miles north of the last locality, the Ferriferous Limestone at a height of 1113 feet, with the coal 89 feet above it.

Hog Hollow Section, No. 2.

Slate.	
1202' Kittanning Middle coal,	2'
Fireclay.	
Concealed,	89'
1113' Ferriferous Limestone,	15'
Interval partly concealed, containing Homewood Sandstone, . .	123'
(Mercer) Coal,	thin.
760' Interval to river level,	215'



Frequent outcrops of one of the Mercer Group of coals are seen on the roadside at a distance beneath the Ferrif-

erous Limestone of 123 feet, more or less. These exposures furnish the section shown by Fig. 137.

The above elevations show another sharp rise of about 55 feet in one and a half miles.

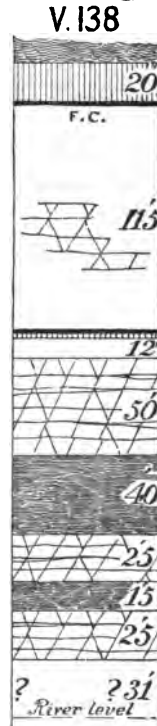
The Kittanning Middle Coal lies quite near the hill-tops with but 50 feet of cover. It is mined principally for local use, but a small quantity is occasionally hauled to New Castle.

At the head of the Hollow and about one and a half miles south from New Castle several good exposures are seen, which being compiled into one section with corrections for dip, give the description illustrated by Fig. 138. The country is not high enough, in this immediate neighborhood, to contain the Middle Kittanning Coal bed.

Hog Hollow Section, No. 3.

Slate, shaly and ferruginous.

1128'	Ferriferous Limestone, grey, 15'	} 20'
1113'	blue, 5'	
	Fireclay,	0' 2"
	Scrubgrass Coal,	1' 6"
	Fireclay.	
	Partly concealed, contains	} 115'
	Homewood SS., some times friable,	
	Coal (Mercer Group),	1' 6"
990'	Mercer Upper (?) Limestone, . .	1' 8"
	Concealed,	12'
976'	Sandstone—quarried (Upper Connoquessing Sandstone,	50'
	Blue slate with ore,	40'
886'	Sandstone,—flaggy, 25'	} Lower } 65'
861'	Slate, shaly, . . . 15'	
846'	Sandstone(exposed) 25'	
790'	Concealed to river level, about .	31'



The Ferriferous Limestone, which tops the above section, is finely exposed in the quarry of Green, Marcus & Co., and consists of fifteen feet of gray underlaid by five feet of blue limestone. It lies immediately on top the hill

with from one to eight feet of cover, and has been stripped from about seven acres of ground. The production when in full blast ranges as high as one hundred and fifty to two hundred tons, nearly all of which is used in New Castle.

The Scrubgrass coal is found just beneath the limestone, but is too thin to mine.

In Hog Hollow the Homewood Sandstone is not a prominent stratum, but at New Castle it is about thirty feet thick and outcrops in several places at a height of about 250 feet above river level. The Mercer Group has been found immediately beneath it but no good exposures can now be seen.

On the road that runs up Hog Hollow, the Upper Mercer Limestone is exposed at an old coal opening. It is said to be somewhat hydraulic.

The Connoquenessing Upper and Lower Sandstones are well exposed on Big Run near the head of the Hollow, where the former has been quarried. It yields a very fair stone but is rather friable. The lower member is split into two—possibly into three—sandrocks, which are parted by late and shale, with streaks of impure coal.

The Sharon Coal bed should occur at the base of the bottom interval of concealed measures, but no trace of it has ever been found.

On the flat at New Castle, and about ten feet above water level, at an elevation of 800 ft. \pm above ocean level, stands the derrick of Messrs. Brown, Reis, and Berger's deep well. By making correction for dip we find that the derrick floor lies about ten feet below the twenty-five foot sandstone, noted at the bottom of the preceding section. The following record (see Fig. 150, plate V) from the original memoranda in the company's books, was kindly placed at our disposal.

(1189) Shenango Iron Company's Gas Well.

OCTOBER, 1875.

On the flat near the furnaces at New Castle, Lawrence county, Pa. Authority, Reis, Brown, and Berger.

Well mouth above ocean in feet, approximately,	+ 800
Gravel,	15 to 15 =
Blue mud and quicksand,	125 to 140 =
Slate rock,	3 to 143 =
Slate,	61 to 204 =
Sand shale,	54 to 258 =
Slate rock,	54 to 312 =
SS., gray,	44 to 356 =
Slate,	26 to 382 =
SS., white, salt water and oil, Berea Grit,	78 to 460 =
Slate,	35 to 495 =
RED ROCK, Bedford shale,	70 to 565 =
Slate,	151 to 716 =
SS.,	43 to 759 =
Slate,	70 to 829 =
Sand shales,	30 to 859 =
Slate,	75 to 934 =
SS., gray,	31 to 965 =
Red rock,	3 to 968 =
Slate,	19 to 987 =
Slate,	207 to 1194 =
Shales, hard,	21 to 1215 =
Slate, hard,	155 to 1370 =
Sand shales,	47 to 1417 =
Slate, hard,	68 to 1485 =
SS., gray,	50 to 1535 =
Slate,	154 to 1689 =
SS., gray,	8 to 1697 =
Slate,	64 to 1761 =
SS., gray,	15 to 1776 =
Slate,	69 to 1845 =
SS., gray,	17 to 1862 =
Slate,	103 to 1965 =
SS., gray,	30 to 2045 =
? about,	655 to 2700 =

Drive pipe, 143—7.12'. Cased with 5½" casing at 468'.

Gas at 313', 617', 657', and 717'. Salt water and oil show at 395'.

This oil is of 32° gravity, dark, and very much like the Franklin oil. It comes to the surface with the salt water, which flows constantly between the casing and drive-pipe, but there is not a sufficient yield to pay for the trouble of collecting it. It is supposed to come in at, or near, the horizon of the salt water. When this well was completed there was a considerable flow of gas. It was then used to light one of the shops. The yield at present is very small.

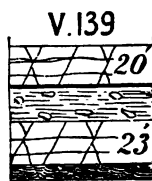
This well was first drilled to 1,965', but was afterwards

sunk to 2,700'. From 1,965' to 2,700' there was no apparent change in the rocks, which consisted mainly of hard, dark slates, with occasional sand shells.

At the E. & P. R. R. station at New Castle there is an excellent exposure of the Connoquenessing Lower Sandstone. It is here, as in the preceding description, split into two rocks by a band of shale. At the base of the upper sub-division a very thin coal seam was detected. This is probably the representative of the Strawbridge Coal of Ohio, which usually lies about 50 or 60 feet above the Sharon (or Block) Coal bed. The upper part of the overlying sandstone is quite micaceous and is probably thicker than the size assigned it in the following description: (See Fig. 139.)

New Castle Section.

972'	Lower Conno-	White micaceous Sandstone, 20'
	Sandstone.	Coal 1'', thin.
		Bluish grey ore bearing shale, 18'
		Shaly white Sandstone, . . 23'
		Shale, 8'
803'		R. R. level.



The Sharon Coal bed should occur at, or a short distance below water level, but it is probably absent.

A cutting on the railroad 1000 feet north of the station exposes a bed of sandstone about 25 feet thick, resting on fifteen feet of shale, and dipping strongly to the south. This is evidently the same with the lower sandrock of the above section.

At Harbor Bridge four miles northwest of New Castle, there is an excellent series of exposures on the west side of the Shenango extending from the top of the Homewood Sandstone down to the base of the Lower Connoquenessing Sandstone, which being compiled into one section, give the succession represented in Fig. 140.

The two foot coal seam noted at an elevation of 972 feet has been opened and mined near the railroad station, yielding quite good coal, but it is too thin for extensive mining.

The Mercer Upper Limestone is exposed in the first ravine below the station at an elevation of 984 feet, and is overlaid by three feet of bituminous shale (coal in Hog Hollow) and

two feet of iron ore, while beneath it are seen three feet of bituminous shale, (very impure coal), eighteen inches of sandstone and three feet of blue slaty shale, below which comes the coal bed mined near the station.

Harbor Bridge Section.

1025'	Homewood Sandstone (in summits),	30' ±	
	Slate about,	6'	
	Nodular iron ore,	2'	
984'	Very bituminous shale,	3'	
	Mercer Upper Limestone,	2'	
	Very bituminous shale (coal),	3'	
	Sandstone (1' 6"),	2'	
	Blue slaty shale (3' 6"),	3'	
	Coal—Mercer Lower,	2'	
972'	Fireclay,	—	
	Interval,	49'	
923'	Hard massive sandstone,	6' to 25'	} Connoquenessing Sandstone Group.
	Blue slate,	22' to 3'	
895'	Coal (5 inches),	thin.	
	Shaly slate,	6'	
	Blue slate,	8'	
881'	Sandstone,	20'	
	Coal (one inch),	thin.	
	Shale,	(8')	
	Sandstone,	(23')	
	Shale to R. R. level,	15'	
805'	Railroad level.		



Fredrickstown Axis.

In Hog Hollow one and a half miles south of New Castle, the Lower Mercer Limestone is nine hundred and ninety feet above ocean level, while at Harbor Bridge it is but eight hundred and ninety-four feet above the same datum, showing a difference of $(990 - 984) = 6$ ft. between the two localities. This distance is about five and a half miles. As

the dip at New Castle is apparently quite sharp, we can only account for the relatively low position of the Limestone at the latter place by supposing that an anticlinal crosses the county somewhere near New Castle. By reference to Plate IV it will be seen that this is exactly where we should expect to find the prolongation of the Fredrickstown Axis.

The Connoquenessing Sandstones are exposed in two ravines a short distance south of Harbor Bridge. The upper rock shows a quite sudden variation, swelling in a short distance from six feet to twenty-five feet. In the first gully there is an exposure of:

Sandstone,	25'	} 28'
Blue slate,	3'	
Coal,	0' 5"	

which in the second ravine has changed to:

Sandstone,	6'	} 28'
Blue slate,	22'	
Coal,	0' 5"	

and clearly demonstrates that in this case at least, *the variation is in the bottom*, and not in the top of the sand-rock.

The five inch coal seam has been opened and a small quantity taken from it for blacksmithing. It is underlaid by fourteen feet of slate resting on twenty feet of sandstone. The latter rock is the upper one of the two sandstones seen at New Castle station. The exposures beneath it were not good, and the measurements below it have been supplied from the New Castle section.

From Harbor Bridge to Nashua the measures rise quite rapidly, averaging forty-one feet per mile. The distance is three miles and the rise in the Upper (?) Mercer Limestone is one hundred and twenty-three feet, being found at the latter place at an elevation of 1107 feet.

The section shown by Fig. 141 was compiled from data collected near Nashua.

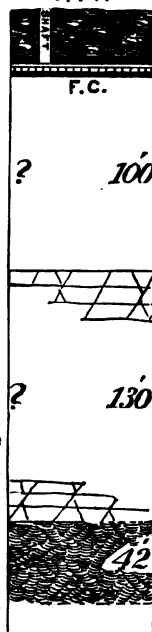
The coal above the limestone from a shaft twenty-seven feet deep is mined, and raised by horse power. The bed averages 2' 9" and yields very good coal.

Nashua Section.

1136'	Mouth of Shaft.	
1136'	Blue slate with ore,	24'
	Coal,	2' 9"
1109'	Fireclay, 1' to 3',	2'
	Limestone (Mercer),	1' 6"
	Coal,	1' 4" to 1' 6"
	Fireclay,	—
	Interval,	100'
1001'	Sandstone, top seen,	—
	Interval,	130'
856'	Flaggy Sandstone,	thin.
	Shales,	42'
813'	Railroad level.	

Mercer Group.

V. 141



The eighteen inch seam beneath the limestone has been opened and worked but is now abandoned. This coal is fair but the bed too thin for profitable mining.

From this coal bed down to river level no good outcrops were observed. The erosion has left the country so rounded, and there is so much local drift on the side hills that it is very difficult to tell the character of rock underlying them.

The Sharon coal should be found at a height of about 100 feet above water level, and the Ohio Conglomerate should also be found above water level.

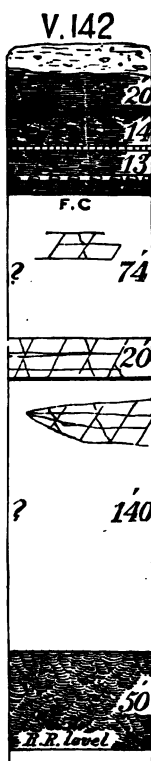
On top the hill west of Pulaski two of the Mercer coals have been opened and worked but long since abandoned. A new drift was being driven in on the upper seam when the following measurements were made, but the coal was not there visible. The position of the limestone (Mercer) was only approximately determined from old iron ore diggings in the same vicinity. Figure 142 shows the section compiled here.

The Mercer Group here exhibits a total thickness of about 60 feet, which is much more than it shows in any of the previously described sections. This thickening takes place both above and below the limestone, for the lower coal is here 24 feet beneath it while at Harbor bridge this

interval is but 10 feet; and the upper coal is 14 feet above the same stratum, whereas at Nashua there is only two feet of fireclay between them.

Pulaski Section.

	Surface,	—
	Slate, about	20'
1148'	Coal,	2' 6"
Group.	Slate with ball iron ore, . . .	14'
1134'	Mercer Upper Limestone, . .	2'
	Blue slate with nodular ore, .	13'
1119'	Fireclay with ball iron ore, .	3'
	Blue slate,	8'
1107'	Mercer Lower Coal,	1' 6"
	Fireclay,	74'
	Interval, with sandstone, . }	
	Sandstone, (top of Connoque-	
	nessing Lower,	20'
1013'	Coal,	0' 5" to 0' 7"
	Interval, with SS. near top, .	140'
823'	Shales—to R. R. level, . . .	50'



The sandrock overlying the thin coal seam was passed through in a bore hole and is reported as 42 feet thick, but surface outcrops show a thickness of only twenty feet. It is the top rock of the Connoquenessing Lower Sandstone and is very variable.

The horizon of the Sharon Coal is one hundred and forty feet more or less above railroad level. Much search has been made for the bed, but as yet no trace of it has ever been found. The thin coal noted in the above description lies about fifty feet above it, and is the "Rider" of the Block Coal,—the Strawbridge Coal of Ohio.

From Nashua to Pulaski there is a rise in the formations of about twelve feet per mile.

About four miles northeast from Pulaski, in boring for the Sharon Block Coal, a good development of the Mercer Group was passed through. This bore hole is situated on the Love Farm, two miles S. 20° E. from Bethel. The same group was also found in a bore hole near Greenfield, about

two miles east of Bethel. The following records were kindly furnished by Mr. Frank Livermore of Neshannock, and the elevations were supplied from levels run by Mr. Strawbridge, mining engineer, of Sharon. By combining the two records we obtain the succession shown in Fig. 143.

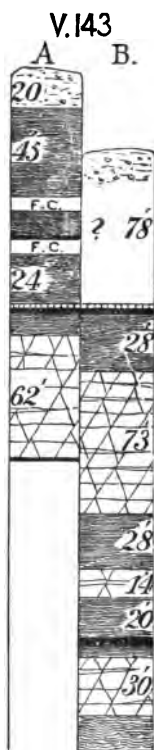
Bore hole on Love Farm (143 A.)

1283'	Surface drift,	20'
	Slate,	45'
	Fireclay,	8'
	Slate,	12'
1198'	Coal (Mercer),	2' 6"
1195'	Firelay,	8'
	Slate,	24'
1163'	Mercer Limestone,	3'
1160'	Coal, 3' to 3' 6",	3'
1157'	Slate,	10'
	SS.—Upper Connoquenessing,	62'
1083'	Coal—(bottom of hole), 1' 6" to 2', 2'	

For convenience of comparison the elevations of the following section have been carried down on the dip to the location of the preceding record.

Bore hole near Greenfield (143 B.)

	Surface,	—
	Interval—not noted,	78'
1163'	Mercer Limestone,	2'
1161'	Coal, 3' 6" to 4',	4'
1157'	Slate,	28'
	SS.—(Connoquenessing rock),	73'
	Slate and fireclay,	28'
	Sandstone,	14'
	Grey slate,	20'
994'	Sharon Block Coal,	4'
990'	Slate,	5'
	Sandstone,	20' or 30'
	Shale,	



This record shows that the Love Farm boring should have been about one hundred feet deeper to reach the horizon of the Block Coal of Sharon, Greenfield and Bethel.

The coal bed overlying the limestone has been opened and arrangements for working it were being made in the fall of 1875. It is of unusual size and rather peculiar character in this locality, being neither a true caking nor a real block coal, and contains much mineral charcoal. It is undoubtedly identical with the seam mined at Nashua.

Both of the preceding records fail to note any sandstone at the horizon of the Homewood Sandstone, and it is possible that this rock is either very thin, quite shaly, or locally absent in that neighborhood.

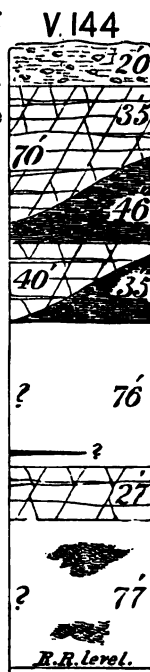
On Mr. Gundy's farm near Middlesex several drill holes have been sunk in searching for the Block Coal, but none of them were drilled deep enough to reach its horizon. Their average depth was about 140 feet whereas the Sharon Coal if present, lies 200 feet more or less below the summits and about 110 to 125 feet above R. R. level.

The thin coal at which the bore holes stopped is not the Sharon Coal, but the Strawbridge Coal lying from 50 to 60 feet above the Block Coal.

The section illustrated by Fig. 144 was compiled partly from the records of these bore holes, and partly from surface exposures:

Middlesex Section.

1154'	Surface,—drift,	20'
1134'	Sandstone,	70' to 35'
1053'	Slate,	11' to 46'
	Sandstone,	40' to 5'
	Slate,—with small coal, 0' to 35'	
1013'	Coal,—bottom of drill holes,	0' 2" to 0' 6"
	Partly concealed, place of Sharon Coal at bottom,	76'
937'	Hard massive sandstone (Ohio Conglomerate,)	27'
910'	Shales with iron ore partly concealed to R. R. level at Middlesex,	77'



The above description begins at the base of the Mercer

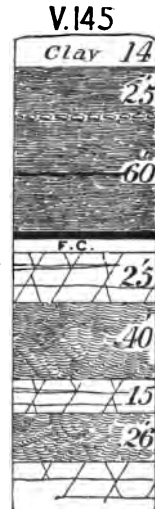
Group which has been eroded from the surface. Large bodies of drift now occupy its horizon, resting immediately on the Upper Connoquenessing Sandstone.

The variations shown by the Connoquenessing Sandstones are quite remarkable, as the bore holes by which these changes were detected are located in close proximity, three of them falling within a radius of 500 feet. The sandstones occupying this interval are always more inconstant in thickness and character than either the Homewood Sandstone or Ohio Conglomerate. The coal shafts near Sharon and Bethel sometimes show wonderful changes in their lithological character, for sometimes one shaft will pass through nothing but sandstone, while another a quarter or half a mile off, will go through nothing but slate.

The sandrock noted in the section at an elevation of 937 feet is exposed in a quarry a short distance from Middlesex Station. It is without doubt, the rock underlying the Sharon Coal bed,—the “Conglomerate” of Ohio, or at least the upper part of that rock. Beneath it the exposures are rather meager: they consist of ferriferous shales, slates, and flaggy sandstone.

Bethel Section.

1123'	Surface level.	
1128'	Clay “hard-pan,”	14'
	Slate,	25'
	Ball iron ore,	1'
	Slate, with a 10" coal seam near middle,	60'
1023'	Block coal,	3' 6" to 3'
1020'	Fireclay,	0' to 6'
	Sandstone,	1' 6"
	Fireclay,	6' to 1'
	“Flag,” SS.,	2' to 20'
	Hard sandstone, . (25') to (5')	
	Interval, (shales ?)	40'
930'	Shale and flaggy ferriferous SS.,	15'
	Shale,	26'
889'	Thinbedded flaggy SS.,	—
	Concealed,	—



In going up the coal railway from Middlesex to Bethel the section represented by Fig. 145 was compiled. The upper part of the description was made from the strata passed through in Spearman, Ulp & Co.'s shaft at the latter place.

The surface has been planed off in the vicinity of Bethel, below the horizon of the Mercer Group.

Above the Block Coal (Sharon bed) we would expect to find the Connoquenessing Sandstones, but that group is here entirely represented by slate. The small coal seam occurring about 40 feet above the Sharon Coal bed is quite persistent but is always too thin to mine. It lies too low to be identified with the Quakertown Coal of Report QQ, and should properly be classed with the Sharon bed, in a group that could with propriety be called the Sharon Group.

Beneath the main coal bed occurs a variable sandrock consisting of two layers; an upper flaggy stratum with a harder and more massive rock beneath it, and forty feet below this is the "ferriferous sandstone." These rocks are undoubtedly identical with a part or the whole of the Ohio Conglomerate.

Quarry near Bethel. (Cuyahoga shale.)

Drift,	10' 0"
895' Shaly light colored Sandstone,	1' 0"
Dark shale,	0' 9"
Shaly Sandstone,	0' 6"
Fine grained white Sandstone,	
with concretions,	1' 0"
Grey fissile slate,	0' 4"
Flaggy Sandstone,	0' 6"
Drab colored shale,	1' 3"
Conglomerate of red shale, black slate and bituminous shale, with iron concretions,	0' 6"
889' Quarry of bluish grey flag,	5' 0"

V.146



At an elevation of 889 feet, and 26 feet beneath the base of the "ferriferous sandstone," a quarry has been opened on a bed of beautiful fine grained flagstone of a light bluish grey color. Five feet only of it are exposed above water

level. It is overlaid by a very peculiar alternation of sandstone, slate and shale, which is shown on an enlarged scale by Fig. 146.

A good section of the rocks overlying the Block Coal was obtained at the Pacific Slope near Sharon. The country is not high enough to contain the Upper Connoquenessing Sandstone except in the highest summits, and these are so smoothly eroded that they present no exposures. The Lower Connoquenessing Sandstone was passed through by the slope, and consists of two members. The upper one of these has been opened and quarried at several places, and yields good building stone.

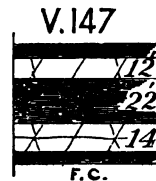
The measurements shown in Fig. 147 were made in the air shaft of this colliery.

Section in Pacific Slope.

Drift,—on surface.

Bluish gray slate,	6'
Thin bedded Sandstone,	12'
Black Slate,	22½'
Compact Sandstone,	14'
Block Coal,	3'
Blue Slate,	3'
Sandstone,	3'

Fireclay—thickness unknown.



The three foot Sandstone underlying the coal may be the only representative of the massive twenty-five foot rock at Bethel, but it is probable that beneath the fireclay in the sump, there is another bed of sandrock.

Dip of the Sharon Block Coal.

At Bethel the coal is 1020 feet above ocean level, at Middlesex 950 feet, and at Sharon (Brookfield Bank) 1067 feet. From this we obtain:

1020'— 950' = 70' = dip from Bethel to Middlesex.
1067'— 950' = 117' = " " Sharon to Middlesex.
1067'—1020' = 47' = " " Sharon to Bethel.

The distances are respectively about 3½, 6, and 4½ miles. Tabulating these data, and adding the courses

$70' + 3\frac{1}{4} = 20'$ per mile S. 69° W. (A.)

$117' + 6 = 19\frac{1}{4}'$ per mile S. 20° E. (B.)

$47' + 4\frac{3}{4} = 10'$ per mile S. 45° E. (C.)

15' per mile S. 20° E. Bethel to Love Farm. (E.)

Greatest dip $27'$ per mile S. 23° W. (D.)

The line of true (greatest) dip was first calculated from (A) and (B)* then from (B) and (C) and finally from (A) and (E), in each case giving the same result, showing that over this area the coal lies in a plane, for were it a warped surface, these results would vary.

Sharon Block Coal.

The character of this coal has already been well described by Dr. J. S. Newberry, in the Ohio reports. In the vicinity of Sharon and Bethel it is an excellent non-pyritous, compact non-caking coal, with usually a low percentage of ash, which however is sometimes increased by the presence of very thin slaty laminae. The bed occasionally contains much mineral charcoal.

Both the roof and floor are very changeable. This is well seen in the Brookfield Bank at Sharon, where the coal is sometimes held between two conglomeratic beds of sandstone, again has a slate roof and floor, with at times a fire-clay floor which is frequently replaced by conglomerate. The overlying sandstone is about twenty-five feet thick, and

* (In the above calculations the following formulae were used for calculating the direction of the line of greatest dip:

$$\tan. X = \frac{\cos. y \cdot D''}{\sin y \cdot D' \sin y}$$

Where, X = angle of required line with greatest given rate.

y = angle of difference between two given courses.

D = greatest dip.

D' = greater given rate of dip.

D'' = lesser given rate of dip.

To find the greatest rate, when course is known :

$$D = \frac{D'}{\cos. X} \text{ or } D = \frac{D''}{\cos (X+y)}$$

For a graphic method see preface.

is generally a hard and massive rock. Beneath the bed are usually found:

Fireclay,	0' to 8'
Conglomerate,	2' to 3'
Sandstone, flaggy,	10'
Sandstone, hard—thickness unknown.	

This sandrock is the upper part of the Ohio Conglomerate, which in Geauga county (Ohio) attains a thickness of 175 feet of solid conglomerate and conglomeratic sandstone. The coal is subject to quite sudden fluctuations in thickness, often being entirely “pinched out” or fining down to a knife edge. It is thickest when there is least fireclay beneath it, and thinnest on the “hills” or where there is most fireclay. This is explainable by the theory that the bed was a swamp deposit of partly drifted bituminous matter. Some of the Ohio colliery maps show very prettily the irregularities of these ancient marshes.

Throughout the Sharon coal region as well as in many other localities, the Connoquenessing sandstones are subject to sudden and radical changes both in lithology and thickness. They are usually soft, rather friable, fine-grained sandstones of nearly uniform texture, and seldom show any signs of approaching a conglomeratic type. In some instances the interval from the Mercer Group to the Sharon Coal is destitute of any sandrock, but is at times—as in the Mahoning Valley, where over 150 feet of sandstone is passed through by some shafts on the Block coal seam—filled by hard sandstones with very thin parting layers of slate or shale.

This irregularity can be accounted for by supposing—

1st. A powerful current transporting pebbles and sandstone during the deposition of the Ohio Conglomerate.

2d. A period of elevation during which the Block Coal was formed, or the filling up of the shallow water with gravel and sand until there was marsh land for the growth of vegetation at the level of the water.

3d. A recurrence of the first current with diminished strength, transporting finer materials, and shifting constantly its position by reason of the variations in elevation

which were taking place during the continental submergence that evidently occurred after the formation of the Sharon Coal bed.

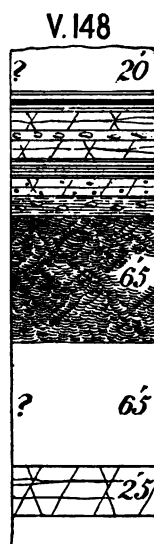
4th. A period of oscillation,—or a refilling of the water basin to its water surface,—in which the Mercer Group of coals and limestones was deposited; and

5th. Conditions somewhat similar to the Ohio Conglomerate period, resulting in the production of that widely spread sandrock and conglomerate which we know under the names of Homewood Sandstone, Tionesta Sandstone, Piedmont Sandstone, "Sixty-foot Rock," of the Butler oil wells, etc., etc.

The section shown by Fig. 148 was compiled by Mr. John F. Carll, from surface exposures on the road leading from Sharon west towards Brookfield. The elevations are barometric.

Sharon Section.

Top of Hill,	1085'
Concealed,	20' to 1065'
Blue coal shales, and smut, (Sha- ron Coal,)	10' to 1055'
Sandstone; thin, yellow, false- bedded,	10' to 1045'
Clay shale, iron concretions, dark,	5' to 1040'
Coarse, yellow, and cong. sand- stone, with carboniferous plants,	10' to 1030'
Blue iron-stained pebbly coal shales,	10' to 1020'
Coarse, shaly, irregularly- bedded sandstone, 5'	<div> <div>10'</div> <div> <div>to 1015'</div> <div>to 1012'</div> <div>to 1010'</div> </div> </div>
Coarse, grey, more mas- sive sandstone, 3'	
Conglomerate in irregular layers, 2'	
Blue sandy shales, kidney ore,	10' to 1000'
Fucoidal sandy shale,	65' to 935'
Concealed,	65' to 870'
Sandstone and shale to river, opp. Furnace,	25' to 845'



The above shows a thickness of 45 feet for the Sharon Conglomerate. The sandrock noted at the base of the section is well exposed in R. R. cuttings south of Sharpsville, where its top lies 50 feet above stream level.

The Sharon Well commenced to drill near the top of this rock, or about 50 feet above river level; but as much drift was passed through before reaching bed-rock, it is not shown in the following, which is said to be a correct record of the strata passed through.

Sharon Well. Drilled in 1877.

Situated near Sharon Furnace, one mile and a half north by east from Sharon. Authority, Mr. Hall, of the Sharon Furnace Company.

Well mouth is about 50 feet above Sharon and about 900 feet above ocean level, and 160 feet, more or less below the Sharon Block Coal, which would place it about 460 feet beneath the top of the Ferriferous Limestone.

Drift,	{ Clay and gravel,	{ Drive pipe, . . . 100' to 100'
	{ Coarse gravel,	
	{ Boulders,	

Shale,	85' to 185'
--------	-----------	-------------

Sandstone, sharp white,	75' to 260'
-------------------------	-----------	-------------

Shales, light blue,—Red Rock near bottom,	305' to 565'
---	-----------	--------------

Sandstone, fine grey,	30' to 595'
-----------------------	-----------	-------------

Shales, blue, grey, and brown, with thin layers		
---	--	--

of fine grit,—no oil or gas,	1005' to 1600'
------------------------------	-----------	----------------

Cased at 280 feet. Fresh water at 175' and 280'. Gas at 485', and oil show of heavy oil with gas in a thin stray sand (probably a "shell") at 618 feet. After passing this stratum bark brownish shales were encountered, which gradually became darker with only a slight brownish tinge and finally merged into dark blue shale, which was the predominating color from that point to the bottom of the well. That the bottom of the well is undoubtedly in the Erie Shales or at any rate in the Erie surface rocks is proven both by the character of the drillings and by the depth of the well.

Lake Erie is 573 above ocean level. Assuming an hori-

zon in the measures at 700 feet above ocean level (or 127 above the lake) and tracing it to Sharon on an assumed line of dip we find it in the well at a depth of 1400 feet, or 200 feet above its bottom. The distance is about 60 miles. A dip of 20 feet per mile would result in a fall of 1200 feet. This gives (700' above ocean — 1200 feet) 500 feet below ocean level. The Sharon well starts at 900 feet above sea level, and $900 \text{ feet} - 500' = 1400 \text{ feet}$.

CHAPTER II.

The Conglomerate Series (No. XII) or Beaver River Series. The Berea Grit.

It has always been a question: What in Western Pennsylvania corresponds to, represents to, or is the equivalent of the Pottsville Conglomerate of the Eastern and Middle regions of the State?

In and surrounding the Anthracite Coal Basins this rock is a massive conglomerate, composed chiefly of quartz pebbles ranging from the size of an ostrich egg down to fine sand; is extremely hard, though sometimes of friable nature; and varies in thickness from 1000 feet at Pottsville to 200 feet at Wilkes-barre.

It is occasionally broken up into several bands by layers of slate which at times carry workable coal beds. The characteristic valley-forming soft Mauch Chunk Red Shale (Umbral) beneath it is always a great formation. The Productive Coal Measures overlying it afford a horizon by which its top may be determined. But although the Lower Productive Coal Measures of the Allegheny Mountains are undoubtedly synchronous with the lower anthracite beds, the wide geographical space of eroded country between the two coal regions has heretofore rendered a good identification of individual beds impossible, except perhaps in the case of the isolated coal fields of Wyoming and Lycoming counties.

The Conglomerate along the face of the Allegheny Mountain ranges from 100 to 250 feet in thickness, and is often composed of two or more sandrocks parted by beds of shale, which seldom contain any coal bed of workable size. Beneath it are the red shales of XI from 100 to 275 feet thick; and beneath these lie the Pocono Sand-

stones of No. X. Above it lie the Lower Productive Coal Measures. It has been shown by Mr. Platt (Reports H, HH, HHH) that the latter may be traced continuously from the mountains westward to the Clarion county line, with the lowest coal (Bed A, Brookville bed) always *a few feet above the upper member of the Conglomerate*. This coal is traced through Butler into Beaver and Lawrence counties and is always found at the same horizon, viz: on, or a few feet above the top rock of the Conglomerate Series, there known by such local names as Homewood Sandstone, (Upper) Beaver Conglomerate and Tionesta Sandstone; and it is this top rock which was called No. XII (or the Conglomerate) by the geologists of the First Survey; a name occasionally still applied to it.

In my forthcoming report on Clinton county and its Sub-carboniferous rocks I will show by a series of vertical sections the variations in No. XII from Lock Haven westward and northward, as well as the correlative changes in the Mauch Chunk Red Shale (XI) Pocono (X) and Red Catskill (IX) strata, and will give data for demonstrating that throughout the northern, central and western portions of the State the Conglomerate is not a single stratum, but always a formation with two, three, four or more members.

The Homewood Sandstone underlying, on the Beaver and Shenango Rivers, the Brookville Coal (Bed A) is a hard massive sandstone forming numerous cliffs and bold terraces; so that even in the absence of any guiding horizon it can often be recognized by its lithology alone; and beneath it is a well developed group of coal beds, with two beds of limestone,*—the Mercer Group. This Homewood Sandstone has always been considered the equivalent of No. XII, in whole, or in part. If in whole, then the Mercer Coals would be subconglomerate, and they have in fact been so described, and their limestones considered as the equivalent of the Limestone of XI. If in part, then we must look for sandstone formations under the Mercer group, to make

* These are probably the two Zoar Limestones of the Hocking Valley report, Geology of Ohio, Vol. III.

out the rest of No. XII. Such sandstones exist, as follows:—

The Connoquenessing Sandstone comes next below the Mercer Group; and it is divided by Mr. White into an Upper and a Lower Connoquenessing Sandstone; but it could be readily sub-divided into Upper, Middle, and Lower; or even into four divisions. As these rocks are very variable in thickness and character, being often nearly or or wholly replaced by shale and slate, they may be called the Connoquenessing Sandstone Group.

Although each stratum of this group is quite variable in hardness and in the size of its sand grains, and subject to sudden thickening or thinning,—sometimes entirely disappearing,—the total thickness of the mass remains nearly constant; for a change in any of its members is sure to be compensated by an opposite variation in the underlying or overlying slate or shale. Its total thickness is from 140 to 180 feet, being greatest where there is the least thickness of the Mercer group.

Is this then the bottom of XII? Or are there still lower conglomerates or sandstones which ought to be included in XII?

In other words is the celebrated Sharon Block Coal,—which constitutes with its rider coal bed and shales the next group downwards—a *Subconglomerate* coal? Or must also this group be considered as *in* the Conglomerate, whether far or near above its base?*

There are in fact three massive Sandstone formations underneath and within 200 feet of the Sharon Coal bed. They are called 1. the Sharon Conglomerate; 2. the Sharon Upper Sandstone; 3. the Sharon Lower Sandstone.

1. The Sharon Conglomerate, with a maximum thickness of about 40 feet, is very variable, sometimes absent or else so shaly as not to be noticeable.

This undoubtedly represents either the top part of the

* The Sharon Block coal has its principal development in the State of Ohio and is there recognized as the lowest productive bed of the Coal Measures. The natural mistake was therefore made of identifying it with Bed A in Pennsylvania, lying more than 200 feet above it, geologically.

Ohio conglomerate or the whole of it. It contains coal-measure fossils, is a coal measure rock, and therefore would seem to be another member of No. XII.

The Shales beneath it, however, hold Waverly fossils; and if palæontological evidence was of itself sufficient to decide the question, the line would be drawn here, and we should say that these shales lie underneath No. XII; and the question would then arise as to what these shales were, if not No. XII.

Would they be No. XI? If so, then the Mauch Chunk Red Shale formation No. XI does *not* thin out to nothing in Elk county, but continues on to and into the State of Ohio.

But if these shales be not No. XI, then should they be No. X, Pocono?

Another question is: Are they Cuyahoga shales?

2. The Sharon Upper Sandstone underlying the above shales is quarried near Jamestown; holds iron balls and Waverly shells, but also many huge *lepidodendra*.

Is this another and still lower member of No. XII? Judging by the shells, no. Judging by the plants, yes.

Another shale formation and much larger than the last underlies this Sharon Upper Sandstone, which is only 15 or 20 feet thick where exhibited and may be as variable elsewhere as all the rest of the sandy deposits of this region.

3. The Sharon Lower Sandstone is more massive and thicker than the Upper. Have we now at last reached the base of No. XII? Beneath it lies a very thick formation of shales, measuring in one place 135 feet.

Whatever the shales *above* may be, these *fundamental* shales* are surely the main body of the Cuyahoga formation of Ohio; and the next succeeding thick and massive Sand-rock at its base must be of course the Berea Grit, the Oil rock at Mecca, or Venango Third Mountain Sand.

It is then possible to state the thickness of No. XII in the western counties of Pennsylvania in at least two ways, thus:

*As we have a Beaver Conglomerate Group a Venango Oil Sand Group, a Warren Oil Group and a Bradford Oil Group, I propose for the *Shales above and below the Berea Grit* the term Crawford Shale Group, as they make the broad belt of lake and swamp land across that county. J. P. L.

Homewood Sandstone, . . . 30'	}	No. XII.	}	265'	}	No. XII ?
Mercer group, . . . 30'						
Connoquenessing group, . 155'	}					
Sharon group, . . . 10'						
Sharon Conglomerate, (Ohio	}					
Conglomerate,) 40'						
Sharon Upper shales, 30'	}					
Sharon Upper Sandstone, . 15'						
Sharon Middle shales, 75'	}	170'				
Sharon Lower Sandstone, . 50'						
Crawford Upper (Cuyahoga) shales, 135'						
Berea Grit, (Third Mtn. Sand of oil men. Carll,) . . . 75'						
Crawford Lower (Bedford red) shales.						

The first view represented in the above schedule will make No. XII consist only of the Homewood, Connoquenessing and Sharon Conglomerates, with the Mercer coal and limestone group and other included intervals sometimes exhibiting streaks of coal, the whole measuring say 265 feet.

In this view of the case the Sharon coal and shales must be considered interconglomerate.

The second view will include in No. XII not only the Homewood, Connoquenessing and Sharon Conglomerates, but also the Sharon Upper and Lower Sandstones, with an intermediate mass of shales, in all 170' thick, making No. XII altogether about 435' thick.

This latter view is taken by Mr. Carll, who recognizes in the Sharon Upper and Lower sandstones of Mercer county the representatives of the First and Second Mountain Sand-rocks of the Oil region, as his numerous well sections show; the Second Mountain sand being thin and variable in the northern part of the Butler oil region, almost invisible in the southern part of it, and a massive conglomerate (Garland) in the Venango oil region, as explained in his report.

For a description of the Conglomerate and allied rocks as they appear in Northern Butler the reader is referred to the chapters on the townships.

In Geauga county Ohio, the Conglomerate (below the Sharon Coal) is said to be 175 feet thick. This agrees quite

well with its thickness in Crawford and Venango counties in Pennsylvania. Beneath it are Cuyahoga shales 150 to 200 feet thick, lying upon the Berea Grit, below which occur the Bedford shales, which are often *Red Shales*.

It would then follow, as asserted by Mr. Carll, that the Third Mountain sand which lies above the RED ROCK of Franklin, Reno, Scrubgrass, Wolf Creek, New Castle, etc., is the Berea Grit; and that the Red Rocks are the equivalents of the Bedford Shales of Ohio.

This identification is more readily understood by reference to Plate VII of well records. The 75 foot rock found in the Sharon well, which I have no doubt is the same with the 78 foot rock of New Castle, the "Big Rock" of the Beaver Falls wells, and the Third Mountain Sand of the Venango Oil District, is then identical with the Berea Grit. Mr. Carll adduces additional proof of the truth of this conclusion by calculating the position of the Mecca (Ohio) oil rock (Berea Grit) at Sharon, from established rates of dip in Trumbull county O. and Mercer county, Pa., by which means he has found that the place at which this rock should be found at Sharon, agrees almost exactly with the position of the 75 foot rock pierced in the well.

Description of Plate VII of Oil Well Records.

John Smith (Muddy Creek) Well Record. Fig. 148.

This well is situated in the south-west corner of Brady township, Butler county, and exhibits a structure typical of the Oil Creek and Bullion stratification, showing the base of No. XII at the bottom of the 100 foot sandrock, an interval of soft measures beneath it 342 feet thick, containing two sandy bands which might be referred to the Conglomerate series, but which are evidently sandy layers of the Cuyahoga Shale, (upper part of No. X,) similar to the lower sandrock at Sharon and those of the Butler oil district. The Third Mountain Sand or Berea Grit 26 feet thick next succeeds, and below it are shales underlaid by the Bedford RED ROCK. The Oil Sand Group, (Lower Pocono, X. (See Report VV,) shows a good development, with all

three of its principal members present, the second and third of which are double.

Wolf Creek Well. Fig. 149.

This is eight or nine miles north by west from the John Smith well, and exhibits the same succession down to the oil sand group. Though the Homewood Sandstone is not noted in the record, it is present in this vicinity, but has been overlooked by the drillers. The Berea Grit is quite thick and lies immediately upon the Red Rock, which is somewhat higher than in the Smith well. This fact is corroborative of the conclusion which I think I have reached in Report VV as to the Red-rocks, that going north-west and west from the best development of Red Catskill, the horizon of deposition of rocks red in color constantly rises, so that the Red Catskill of the east becomes Lower Pocono (X) in the west, or in other words the former disappears, and the red rocks are found in the lower half of the Pocono.

In this well the Oil Sand group contains no Second Sand, being similar to the Raymilton and Church Run type of drillings.

Sharon Well. Fig. 150.

This starts near the top of the Sharon lower sandstone which has been called by some the Berea Grit, but which has already been proven to be but a sandy part of the Cuyahoga of which there is 150 feet more at Sharon than on the Cuyahoga in Ohio. The Mecca oil rock (Berea Grit) seems to have been struck at a depth of 185 feet in the well, but no red rock is noted under it.

In the 305 foot interval, the record says "red bands near the bottom." It is possible that they have not been correctly recorded by the drillers, but as these red bands both in Pennsylvania and Ohio occur only over certain areas and are replaced by grey shales in many localities, their absence here is not conclusive.

The oil group is probably cut out by the Chemung floor, but may be represented by the 30 foot sand rock.

New Castle Well. Fig. 151.

This well starts at the Sharon Coal horizon but as 143 feet of drive pipe was used before reaching rock bottom, the Sharon Conglomerate is not shown in the record. Two sandy layers were encountered in the Cuyahoga Shale before reaching the Berea Grit which is here 78 feet thick and underlain at a short distance by the big *Red Rock* of the Bedford Shales. The sands noted below the latter look like grey Chemung sands, and were only noticed because the drillers were very closely watching for the oil sand group.

The thin three foot red band may be one of the Chemung red bands so common in the northern part of the State. When these red beds are thick the red color is very indistinct, being usually of a dark purple rather than red, but when thin they are often quite brilliant.

The Ohio Section. Fig. 152.

This needs no commentary. It is simply a compilation from the reports of the Geological Survey of Ohio, and explains itself.

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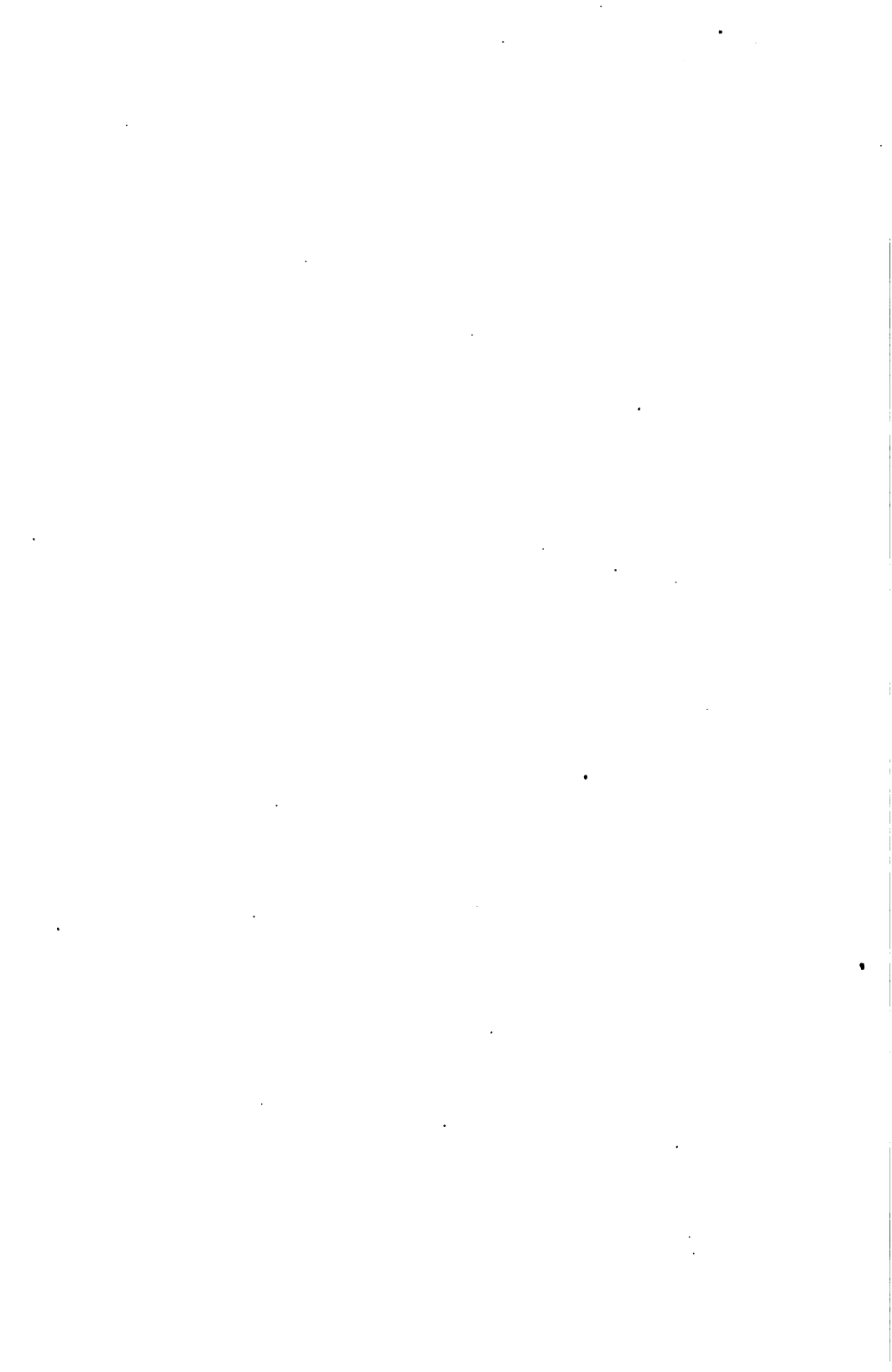
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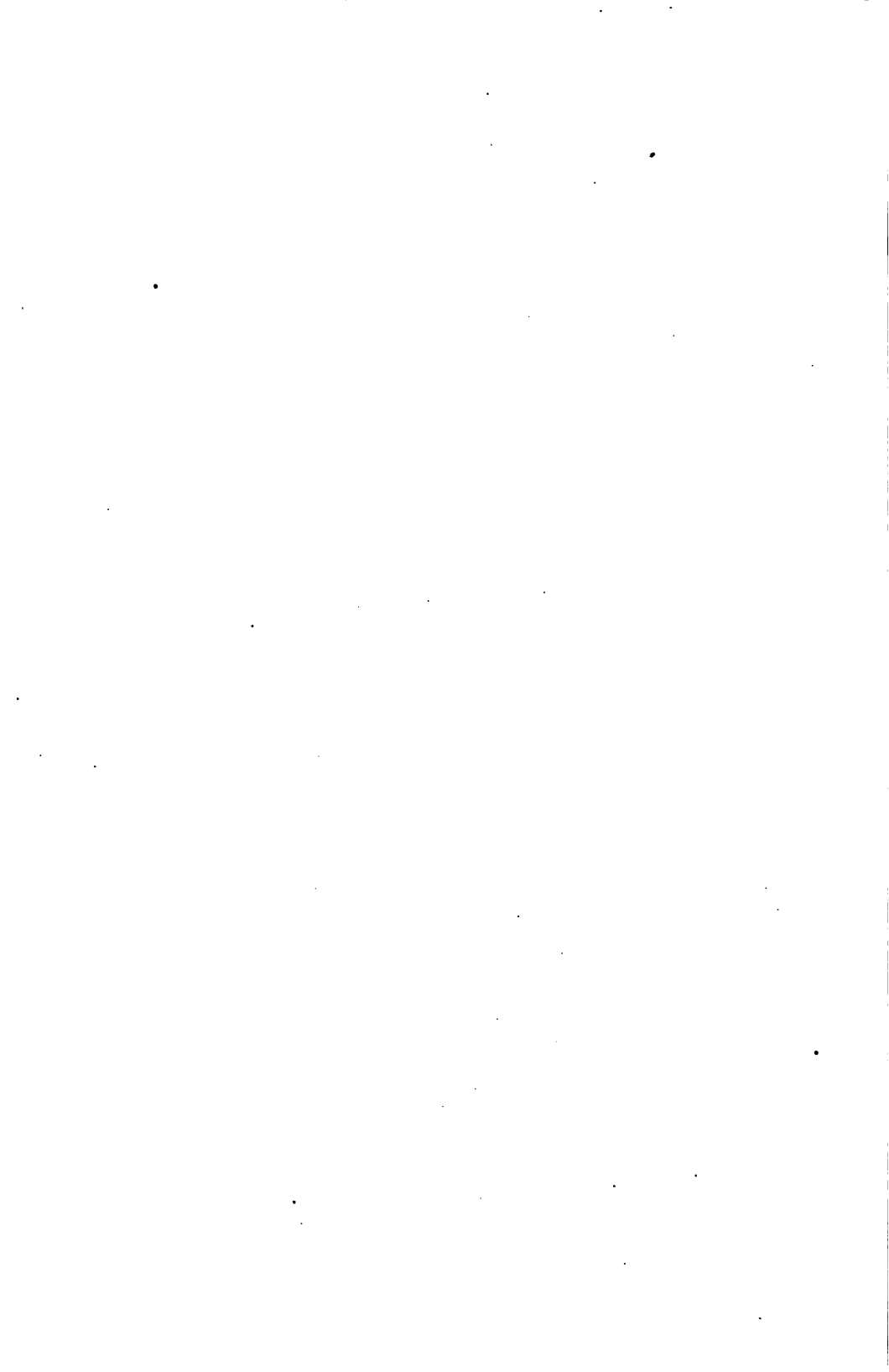
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